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PLATE I.

Inorganic urinary sediment. A, uric acid crystals; B, triple phosphates, tricalcium and ammonia magnesium; C, amorphous urates; D, cystin; E, calcium phosphate crystals (simple acid); F, phenylglucosazone crystals; G, indigo matter (alkaline urine); H, calcium oxalate; I, hæmatoidin (vesical hemorrhage); J, bilirubin; K, calcium carbonate; L, leucin; M, tyrosin: N, ammonium water (various types). (See page 14.)

WHITE AND MARTIN'S

GENITO-URINARY SURGERY AND VENEREAL DISEASES

BY

EDWARD MARTIN, A.M., M.D., F.A.C.S.

JOHN RHEA BARTON PROFESSOR OF SURGERY, UNIVERSITY OF PENNSYLVANIA

BENJAMIN A. THOMAS, A.M., M.D., F.A.C.S.

PROFESSOR OF UROLOGY IN THE GRADUATE SCHOOL OF MEDICINE OF THE UNIVERSITY OF PENNSYLVANIA; INSTRUCTOR IN SURGERY, UNIVERSITY OF PENNSYLVANIA; GENITO-URINARY SURGEON TO THE PRESBYTERIAN HOSPITAL, PHILADELPHIA

AND

STIRLING W. MOORHEAD, M.D., F.A.C.S.

ASSISTANT SURGEON TO THE HOWARD HOSPITAL PHILADELPHIA

ILLUSTRATED WITH 424 ENGRAVINGS
AND 21 COLORED PLATES

ELEVENTH EDITION

PHILADELPHIA AND LONDON
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DEDICATED TO

J. WILLIAM WHITE, M.D.

PREFACE TO THE TENTH EDITION

THE Tenth Edition of this book appears long after the Ninth has been completely exhausted, not for any lack of enterprise and urging upon the part of the publishers, but because the authors have felt that the work must be reset, rewritten and reillustrated to fairly and yet succinctly present the views and practices of to-day. This has implied a careful study of current literature and the selection therefrom of that which seems of permanent value. Also an omission of much that the fashion of the day has passed because it has been supplanted by something better.

We have incorporated in the text a brief but practical presentation of vaccines and serums; tests of renal function which are found most serviceable in estimating operative risks; high frequency desiccation; laboratory diagnosis of syphilis and control of treatment; the accepted conservative and radical treatment of prostatic hypertrophy including those measures which have done so much to lower mortality. We have endeavored fully to present those therapeutic methods which have received the general approval of the clinically experienced.

We have not found, practically, that a continued positive Wassermann is a condition to be heroically combated at the expense of the patient's health, nor are we in accord with the belief that old symptomless syphilitics should receive either prolonged and continuous treatment or intensive courses with the sole view of changing their Wassermann, though we believe that such patients should be given intermittent treatment short of producing drug reaction through life and that mercury and iodides should be the basis of this treatment.

We have not been convinced of either the safety or the special value of subdural injections in cerebrospinal syphilis, ataxia or paresis.

In the rewriting the original authors have had as associates Dr. B. A. Thomas and Dr. S. W. Moorhead, whose special work has made them thoroughly conversant with the present laboratory and hospital methods of diagnosis and treatment.

EDWARD MARTIN.

September, 1917

PREFACE TO THE FIRST EDITION.

In the preparation of this work we have endeavored to present clearly and with sufficient detail the generally accepted teachings of the day in regard to the pathology, symptomatology, diagnosis, and treatment of syphilis and genito-urinary diseases.

We have exercised the author's right of choice in estimating the comparative value of various methods of treatment, and have given chiefly those which our experience has led us to prefer, though alternative methods are usually mentioned. As it was our wish to make this book one of practical use to the physician, much space has been devoted to symptomatology, diagnosis, and treatment. The pathological alterations characteristic of the diseases and injuries described have been briefly outlined, avoiding discussion of questions still unsettled. Historical considerations have been abbreviated as much as possible, and references have been omitted, though proper credit has been given for special methods or teachings.

Emphasis has been laid upon genito-urinary antisepsis and the details of operative and manipulative technique, since thorough understanding of these matters must form the foundation for all good work in genito-urinary surgery.

The modern methods of examination of the various portions of the urinary and genital systems have been described with fulness, since only upon familiarity with them can exact diagnosis and scientific therapeutics be based.

We have included an exceptionally comprehensive study of the changes in the urine and its constituents produced by disease, a subject so intimately connected with the specialty to which this work is devoted as to deserve much more attention than it usually receives in surgical text-books.

While we have freely discussed established facts relating to the recognition or treatment of disease or injury, and important theories bearing on questions of surgical therapeutics, we have tried to avoid the confusion which is apt to result from the effort to be encyclopædic. Our views have been put in such form as to be of practical use to the general practitioner and the medical student, since we feel that our experience as hospital surgeons and as teachers during a number of years has familiarized us with their needs.

In the sections on Stricture of the Urethra and Treatment of Syphilis we have used portions of the articles on those subjects contributed by Dr. White to the volumes on Genito-Urinary Diseases and Syphilology of Morrow's System of Genito-Urinary Diseases, Syphilology, and Dermatology.

We must also express our thanks to Dr. G. H. Fox for placing at our disposal his admirable collection of photographs, to Messrs. Charles Lentz & Sons, of Philadelphia, for the illustrations of surgical instruments contained in the volume, to Mr. Joseph McCreery for his aid in the correction of the proofs, to Mr. Samuel Macmeney for much kindness in seeing the book through the press, and to Mr. G. E. H. Weaver for preparation of the index.

J. William White.
Edward Martin.

Philadelphia, January, 1897.

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GENITO-URINARY SURGERY AND VENEREAL DISEASES

CHAPTER I

EXAMINATION OF THE PATIENT

Since examination of a patient is conducted for the purpose of so directing his treatment that he shall be completely restored to health, it is obvious that this purpose often will not be attained unless in addition to detecting gross abnormalities the examiner makes a further search for all other conditions which may have a bearing upon the development and course of his major lesion, may influence its treatment, or may persist as troublesome or devitalizing agencies after the major lesion has been cured. If, for instance, a patient be suffering from a chronic gonococcic urethritis, as shown by a urethral discharge containing gonococci complicated by swelling of the knee-joint, the cure of neither the major ailment nor its complication will necessarily be effected if there be an unrecognized accompanying oxaluria, chronic follicular tonsillitis or colonic stasis. It follows that the percentage of cures will be higher when such affections are treated by practitioners who make a thorough examination a matter of routine.

This examination should include a brief family history, the previous medical and surgical history of the patient with especial reference to affections of the genito-urinary organs, a history of the complaint for which the patient seeks professional help, particularly in regard to its cause, onset, progress, and effect on the general health, and a general and local examination, supplemented, when needed, by laboratory methods. The following are given as suggestive headings for such a history:

1. **Name, residence, occupation, nativity, age, social condition.**

2. **Chief Complaint.**—Effect on mode of living.

3. **Family History.**—Health of parents, sisters, brothers, and nearest relatives. If some or all be dead, the causes therefor, and the ages at which death occurred. Tuberculosis (cough, limp, crooked back, dead bone). Syphilis (stillbirths or heavy infant mortality, aneurism, progressive paralysis, locomotor ataxia). Diabetes. Hæmophilia. Tumors. Malformations.

4. **Previous Medical History.**—Mode of life. General condition of health, strength, endurance, digestion, and sleep. Condition of bowels. Acute infectious diseases with sequelæ, if there have been such. Cough. Surgical operations. Affections of bones or joints. Trouble with eyes or ears. Disturbances of the nervous system.

5. Sexual History.—(a) Temperament. (b) Age of beginning masturbation. Frequency of the act and time of its discontinuance. The effect of the latter upon nocturnal pollutions. (c) Frequency and normality of coitus. (d) Frequency and vigor of erection. Promptness of emission. Immediate effect upon erection of emission. In women the onset and character of menstruation.

6. Venereal History.—Urethral discharge. Sores upon the external genitals or elsewhere lasting more than a few days, skin eruptions, sore throat.

7. Previous Urological History.—Late bed-wetting. Nocturnal or diurnal incontinence. Frequency of urination. Force, volume and steadiness of stream. Promptness and ease of beginning the act. Sharpness of cut off. Total quantity passed in twenty-four hours. Immediate effect of ingestion of fluids. Average quantity passed with each act of micturition. Retention of urine. Passage of blood or calculi. Instrumentation.

8. History of Present Ailment.—A brief statement, from the patient's standpoint, of the cause, onset, progress and chief symptoms of the condition for which the surgeon is consulted. Amount of weight lost; rapidity of loss and impairment of bodily and mental vigor and endurance.

CLINICAL AND LABORATORY EXAMINATION.

I. General Observations.—Height. Weight. Color (jaundice, pallor, pigmentation, etc.). Temperature (if fever, its type and variation). Pulse (frequency, tension, volume, rhythm, and the effect upon it of active exercise). Blood-pressure. Respiration (rate and character). Condition of superficial arteries and veins (sclerosis, pulsation, etc.). Muscular tonus. Eruptions or their scars. Superficial lymphatic glands. Œdema. Malformations.

II. Regional Examinations.—*Head.*—Alopecia, complexion, expression, etc. Conformation. Irregularities of the bony surface.

Eyes: Evidences of present or past inflammation. Corneal opacities. Muscular insufficiency or paralysis. Pupils, abnormality in conformation or reaction. Acuity of vision. Retinoscopy, where indicated.

Nose: Deformity, rhinitis, ulceration, necrosis.

Ears: Functional perfection, evidences of present or past inflammation.

Mouth: Scars. Ulceration. Functional potentiality of the teeth and their condition. Gums. Tonsils. Pharynx. Larynx and vocal cords when symptoms indicate such an examination.

Neck.—Freedom of motion. Lymph-nodes. Thyroid.

Thorax.—Conformation and development, degree and symmetry of expansion and type of respiration (costal, abdominal).

Lungs: Palpation, percussion, auscultation (anteriorly and posteriorly).

Heart: Outline, apex beat, character of sounds (murmur, friction, thrill, etc.)

Abdomen.—Inspection. Conformation (fat, thin, retracted, sagging). Musculature. Venous circulation (if visible). Peristalsis. Hernia. Palpation (rigidity, contained organs, fluid, tumors, palpable masses, peristalsis). Percussion (position of viscera, tumor, fluid). Auscultation (peristalsis, friction).

An examination as comprehensive as that indicated above is usually not undertaken, because, until within recent years, the realm of genito-urinary

surgery has been dominated by the venereal affections, many of which, as they are presented to the surgeon, occur in otherwise healthy young men, are easily recognized, and make a prompt convalescence, providing the treatment be not too meddlesome. With a broader appreciation of the factors which are operative in causing pathological conditions of the kidney, for instance, and some knowledge of the rôle played by gastro-intestinal toxæmia, by an over-functioning thyroid, by cardiovascular disturbances and degenerations, and by foci of infection, the value of a searching examination in at least a certain proportion of cases presenting themselves for treatment is obvious. With the growing efficiency of laboratory methods there is a tendency to somewhat minimize the importance of the older methods which are summarized under the heading "Inspection and Palpation." Either may be the diagnostic means at our disposal.

The methods applicable to the particular region under investigation are described under the headings of the various organs involved. In view of the protean symptomatology of tabes, an investigation of the reflexes whose condition establishes its diagnosis of cardinal importance to the surgeon, and should be made in practically every case on which he intends to operate.

EXAMINATION OF THE GENITO-URINARY SYSTEM

Clinical Examination.—Inspection and palpation of abdomen, loins, inguinal regions and external genitalia for enlargements, misplacements, alterations in density or congenital deformities.

Palpation of the prostate, seminal vesicles and the ampullæ of the vasa; in women palpation of the uterus, tubes, and ovaries.

Inspection of the urine voided in at least two portions in the presence, preferably in the sight, of the examiner that he may observe the size, form, continuity, and force of the stream as well as the appearance of the secretion itself, whether clear, cloudy, bloody or studded with shreds, together with the distribution of the abnormal elements in the different portions.

Instrumental Examination.—Of the urethra, to determine its length, calibre (and variations thereof with their location), and the appearance of its mucosa, made by means of catheter, urethrometer, bougie, and urethroscope.

Of the bladder, to determine its capacity, irritability, ability to completely empty itself, and the presence or absence of foreign bodies and intravesical lesions, made by means of catheter and irrigator, vesical sound, and cystoscope.

Of the ureters and kidneys, to determine their number, position, size, conformation, the presence or absence of stone, and, when needful, their individual function, made by means of the cystoscope, ureteral catheter, injection of certain dyes and drugs, and the X-ray.

The determination of the amount of urine secreted in the course of the twenty-four hours is an important part of the clinical examination, though obviously it cannot be ascertained in the office or operating room.

Laboratory Examination.—Urinalysis.

Completion of tests for the determination of kidney function begun in the operating room, ward, etc.

Examination of normal and pathological secretions by means of smears, inoculation of culture media, and by animal inoculations.

Examination of the blood, microscopical and serological.

CARDINAL SYMPTOMS AND SIGNS

There are a few cardinal symptoms and signs so commonly the exponents of lesions of the urological system that a special study of their expression seems needful. These are pain, hæmaturia, pyuria, frequency of urination, alterations in the stream, suppression of urine, retention of urine, and incontinence of urine. To the last three is given separate consideration in Chapter VI.

Pain.—Pain symptomatic of pathological conditions of the urinary tract is subject to so many variations in degree, is so often referred to regions other than the seat of disease, and is so affected by vesical tension and by micturition, that a serviceable classification of the manifestations of this symptom is difficult. Perhaps the subject may be best considered under the following heads:

1. The character and intensity of pain.
2. The region of pain.
3. The relation of pain to the act of micturition.

The Character and Intensity of Pain.—Pain symptomatic of urinary affections may vary from an apparent muscular stiffness comparable to that following active exertion, and noticed only on movement, or a dull ache readily forgotten when the mind is employed, to a severe pain distracting the attention and seriously interfering with the business of life, or to an unbearable anguish producing vomiting, syncope, and sometimes death.

The pain may be aching and rheumatoid, as in renal congestion, may be burning, as in cases of prostatocystitis, may be shooting and lancinating, as in vesical neuralgia, or may be tearing and griping, as in renal colic.

It may be steady, as in vesical carcinoma, it may be intermittent, as in bladder stone, or it may be continuous with violent exacerbations, as in calculous pyelitis or acute hydronephrosis. If the suffering incident to acute blocking of the ureter be excepted, most of the pain of urinary disease comes from the bladder and prostatic urethra.

Diseases of the kidney and its pelvis are comparatively painless, provided there is free drainage through the ureter. A calculous pyelitis may last for years with no symptoms other than backache, aggravated on motion, or there may be frequent paroxysms of agonizing pain, and indeed this may occur in pyelitis without calculi. These paroxysms are due to acute retention, caused by valvular formation, plugging of the ureter by pus or blood, or blocking of it by calculus.

Inflammation of the ureters in itself occasions no pain which can be recognized as characteristic. It is, however, so frequently complicated by partial or complete stoppage, with consequent tension of the kidney capsule, that patients suffering from this form of inflammation are subject to violent attacks of colic. The absolutely unbearable pain of a kidney stone passing along the ureter is probably due more to spasmodic mechanical blockage of this canal and consequent retention of urine in the kidney pelvis than to mechanical erosions caused by the passage of an irregular foreign body. This hypothesis would seem to be confirmed by the comparative painlessness of ureteral catheterizations.

The pain of bladder disease, aside from that caused by muscular contraction incident to micturition, is proportionate to the intensity of the pathological

process. Chronic cystitis causes very little pain. Acute cystitis and acute retention are extremely painful.

The suffering incident to inflammation or erosion due to a calculus or a foreign body varies greatly. In general, large smooth calculi are less painful than those which are small and irregular. Malignant growth of the bladder may be absolutely painless until it becomes complicated by cystitis or infiltrates the muscular walls. Even under these circumstances pain may be slight or bearable. It is often, however, constant, subject to spasmodic exacerbations, and more intense and wearing than any other form of vesical pain except that due to retention.

Tuberculous ulceration may be painless, except during and after micturition. When the lesions are situated in the trigonum they may cause constant burning wearing pain, with reflexes to the rectum, anus, perineum, and inner surfaces of the thighs.

The Region of Pain.—Pain is generally felt in the region involved. Thus, in acute hydronephrosis or chronic pyelitis the pain is constantly referred to the region of the kidney, though reflexes may be so pronounced as to make this fact apparent only after careful questioning of the patient. Inflammation of the bladder usually causes pain directly in the vesical region.

Sometimes no pain is experienced at the seat of lesion, the abnormal sensation being referred to the distribution of anastomosing nerve-trunks or to the terminal extremities of the nerve irritated. Thus, disease of the kidneys constantly gives rise to pain which is felt chiefly in the groin, down the thigh, or in the testicle. The irritation caused by stone in the bladder produces urethral pain, felt a short distance back from the meatus. Inflammation of the trigonum frequently causes itching, tickling, and painful spasm of the anal sphincter.

Occasionally the healthy bladder may be the seat of almost unbearable pain, due entirely to inflammation of the kidney pelvis. As a rule, lesions confined to the upper half of the ureter produce renal symptoms, while those in the lower half give rise to vesical irritability, etc.

The pain of kidney disease of one side may be referred to the opposite healthy side, or to the shoulder, the groin, the urethra, the testicle, the inner surface of the thigh, the calf, or the heel. (This pain in the heel is also a reflex from the prostatic urethra.)

Pain of bladder trouble may be referred to the suprapubic region, the sacral or lower lumbar vertebræ, the glandular urethra, the kidneys, the perineum and anus, the inner surface of the thigh, and the sole of the foot. All these transferred pains may be symptoms of inflammation of the prostatic urethra.

Diffuse suprapubic pain generally indicates disease posterior to the vesical sphincter. If *constant,* it suggests advanced vesical atony, vesical carcinoma, severe chronic cystitis, perivesical abscess or inflammation, and rarely ureteral disease. If *transient* in duration and *provoked by micturition,* it suggests prostatic enlargement with residual urine. When *increased by micturition,* it generally means vesical tenesmus in a partially atonic bladder. The transient suprapubic pains of all grades of cystitis, tuberculosis, and ulceration of the bladder and of chronic prostatic inflammation are relieved by micturition.

Perineal pain always signifies disease of some structure in intimate relation

with the bladder neck or base, or of the prostatic or membranous urethra. If *constant,* chronic prostatitis, beginning prostatic hypertrophy, carcinoma, and encysted calculi are suggested. If *transient* and relieved by micturition, acute inflammation and tuberculous disease of the prostate or vesical trigone must be considered. When increased by micturition, it suggests either inflammation posterior to the vesical trigone, such as might be caused by calculi pouched behind an enlarged prostate, or tuberculous infiltration, or involvement of the bulbous or membranous urethra, such as would result from sub-urethral abscess, or inflamed stricture, carcinoma, or—rarely—tuberculosis.

Pain referred to the glans penis, whether constant or occurring only at the beginning or during the act of micturition, always implies disease of some part of the urethra or the prostate. If constant, prostatorrhœa, chronic inflammation of the prostatic urethra, or beginning enlargement of the prostate gland is indicated. If occurring just before micturition, urethral obstruction either from clot retention, calculous impaction, or senile prostatic enlargement is present. If present throughout micturition, it may be due to some local lesion in the urethra; either inflammation, a granular patch, ulceration, neoplasm, or a narrow meatus. If present only at the end of micturition, it may be due to a pathological condition at or near the internal (vesical) orifice of the urethra, such as severe prostatic inflammation or congestion, vesical tumors impinging on the internal urethral orifice, inflammation of the trigone, ulceration of the posterior or lateral walls of the bladder, any form of acute localized inflammation in any part of the bladder causing spasm involving the neck, vesical calculus, or the vesical spasm of renal colic.

Chronic inflammation of the prostate is usually characterized by a more or less constant pain referred to the sacrum. In seminal vesiculitis this pain is referred to the hip-joint. In nephritis or pyelitis it is referred to a point just below the last rib to the outer side of the erecta spinæ muscle and is not affected by the act of micturition.

The Relation of Pain to the Act of Micturition.—Pain may be experienced before, during, or at the completion of the act of micturition.

Pain preceding micturition is due to a hyperæsthetic condition of the vesical mucosa or the prostatic urethra. This hyperæsthesia may be caused by various neuroses, by congestion, or by inflammation,—the tension of the full bladder causing distress. If the urine is strongly acid or concentrated, as in cases of rheumatism, gout, or acute fevers, even the healthy mucosa may be irritated, and may be the seat of burning or discomfort, relieved by emptying the bladder. Exceptionally pain before urinating is a symptom of disease of the kidney pelvis.

Micturition pain is also occasioned by irritable or inflammatory conditions of the bladder or prostate, since the muscular contraction required to expel urine necessarily disturbs the hypersensitive tissues. Ulceration or inflammation of the vesical neck is particularly liable to cause urination pain. The sensation may be aching, burning, shooting and darting, or distinctly neuralgic in type.

Pain after urination, generally considered characteristic of stone, may be caused by any inflammatory or ulcerative condition of the bladder neck. In many cases it is probably due to fissure or erosion, and is comparable to the pain felt after defecation in cases of anal fissure. The probability that this is the

cause of the severe forms of suffering is still further increased by the fact that it is commonly associated with tenesmus and involuntary contraction of all the perineal muscles, and that it is relieved by local applications.

When pain at the end of urination is greatly increased by exercise or jolting, and is relieved by rest in bed and by urination in the dorsal decubitus, it is probably due to calculus or to foreign body. The pain at the end of micturition caused by tuberculous ulceration at the neck of the bladder, or exceptionally by cystitis, may also be relieved by rest and be aggravated by motion, but not to the same extent as is observed in calculus.

Aside from pain due to distinct lesions of the urinary tract, there is apparently a pure neurosis characterized by continuous or intermittent pain amounting sometimes to veritable anguish felt in the bladder, suprapubic region, or perineum, by frequent urination, and, unless the desire to empty the bladder is at once gratified, by incontinence. There is usually nocturnal remission, the patient sleeping soundly for several hours. The symptoms vary in intensity; active pursuits, either of mind or of body, cause marked temporary amelioration.

Exploration proves the urethra and bladder to be exquisitely sensitive. This condition is termed irritable or neuralgic bladder, and is sometimes a symptom or prodrome of tabes, though it is more commonly a reflex from the rectum, anus, or generative organs. It has been observed in association with influenza, rheumatism, gout, and malaria.

Hæmaturia.—The vascularity of the urinary tract and the readiness with which it becomes engorged are reasons why blood is so often found mixed with the urine, and why it may be profuse from apparently slight causes.

The color of the urine is not an absolute proof of the presence of blood, since an excess of uric acid or of bile-pigment, or the ingestion of senna, rhubarb, or carbolic acid, or the presence of hæmoglobin, gives a similar reddish or brownish tint. The diagnosis must therefore be founded on a microscopic, spectroscopic, or chemical examination (see p. 18). In cases of pyelitis and cystitis the blood may be found irregularly mixed with the purulent deposit, imparting none of its color to the supernatant liquid.

Clots may be dark red and readily broken up, or tough and yellowish red, suggesting the appearance of organized tissue. A microscopic examination is required to distinguish these fibrinous clots from fragments of neoplasm.

A long, thin, rounded clot in the shape of a small earthworm must necessarily have been moulded in the ureter, and hence indicates either renal or ureteric origin of bleeding. Short cylindrical clots have not the same significance, since they may have been formed in the urethra.

Since congestion is so important a predisposing condition to hæmaturia, it sometimes happens that symptoms of this engorgement precede hemorrhage. There may be a sensation of weight and discomfort rather than actual suffering, or an attack of kidney colic. These pains are of brief duration, are felt in the region of the kidneys or along the ureters, and strongly point to the renal origin of bleeding. Such premonitory pains are rarely felt in bleeding from the bladder.

Blood which appears with the first jet of urine (initial hæmaturia), the remainder of the liquid remaining clear, must necessarily come from some portion of the urethra. In this case the quantity of blood must be very slight, otherwise

it would escape externally if it came from the anterior urethra, or would flow back into the bladder if from the prostatic urethra.

When all the urine contains blood, but that last passed contains the greatest quantity, the last few drops micturated being nearly pure bright blood, the probability of the vesical or prostatic origin of the bleeding is very strong. If blood is passed only at the end of micturition (terminal hæmaturia), the blood must necessarily come from either the bladder or the prostatic urethra. It is particularly in prostatocystitis that terminal hæmaturia is observed. The bleeding is not profuse, and is associated with other symptoms of cystitis, notably frequency and urgency.

The quantity of blood in the urine is of some diagnostic value. If the bleeding is apparently causeless, intermittent, and profuse, it is usually due to renal or vesical tumors, though tropical parasites in the urinary tract, notably the distoma, may cause severe bleeding.

Bleeding may be caused by cantharides, turpentine, mercury, or the ingestion of certain foods. Renal telangiectasis has been reported as a cause for blood in the urine, and this symptom regularly follows renal thrombosis and infarcts.

Essential idiopathic hæmaturia implies bleeding from a healthy kidney. Convincing evidence that this occurs is wanting, though it is true that vasomotor paresis of toxic origin, particularly that incident to a wasting infectious disease, such as typhoid fever, may cause blood in the urine without demonstrable adequate renal lesion. The hemorrhage in such a case may be so alarming as to threaten life.

Blood may appear in the urine in the course of hæmophilia, or because of parasites (*Filaria sanguinis hominis*), closely simulating the surgical forms of hæmaturia. When it is due to infectious fevers, such as variola or scarlatina, to dyscrasiæ, such as scurvy or purpura, or to the vasomotor instability of hysteria, it is not likely to be confounded with hæmaturia which is mainly local in origin.

When hæmaturia follows sudden muscular action or apparently insufficient violence, this is probably due to the presence of a hitherto unsuspected lesion. The conditions which commonly precede the bleeding are tumor, tuberculosis, and nephritis.

In general terms, when urination causes bleeding, stone, tumor, or tuberculosis may be suspected. Hæmaturia due to new-growth, whether this be of the bladder or of the kidney, is usually profuse, apparently causeless, intermittent, made worse by exercise, not cured by rest. The freest bleeding may come from the smallest papilloma.

A tumor, if not placed near the vesical neck, may occasion no symptoms other than hæmaturia, and in its early stages may readily escape detection by palpation.

In determining the source of bleeding, evidence afforded by analysis of associated symptoms and by direct examination must be carefully considered. If the bladder is sufficiently affected to cause bleeding from its mucous membrane there will usually be frequency, urgency, and pain if the case be inflammatory or traumatic; or a bimanual examination will show some alteration in the vesical walls or in the prostate if there be infiltration of tumor.

The first symptom of tumor of the bladder is hæmaturia, unless the growth

is placed near the vesical orifice, in which case frequent micturition may precede the appearance of blood. (Fenwick.)

Tumors of the bladder are often complicated by cystitis.

The bleeding from chronic Bright's disease is moderate; exceptionally it is intermittent and profuse. In acute hemorrhagic nephritis the loss of blood may produce a serious anæmia, and even threaten life. Other symptoms of the disease, and particularly the results of urinary examination, suggest the cause of hemorrhage. The hemorrhage of syphilitic glomerular nephritis can be diagnosed only by the associated symptoms of the disease.

Hæmaturia of renal tuberculosis is characterized by pain, often amounting to true renal colic, pus in the urine, which persists, and a moderate amount of blood, appearing intermittently. Renal calculus also occasions but a slight amount of bleeding and causes pain in the back which is reflected in various directions, the bleeding, the attacks of colic, and the pain being relieved by rest. The same amelioration is not noted in either tuberculosis or new-growths.

Stone in the bladder causes blood in moderate quantity. At times when the stone is complicated by enlarged prostate blood is the only symptom. Bleeding from tuberculosis of the bladder is also slight, occurring particularly at the end of micturition. The effect of rest upon symptoms of stone is so marked and immediate that this is a diagnostic sign of distinct value. Hæmaturia which is not materially influenced by either exercise or rest is usually due to tuberculosis, new-growth, or acute inflammation.

The renal and vesical hemorrhage following catheterization of an overfull bladder will be discussed later (see p. 62). Acute cystitis may exceptionally cause such free bleeding that the term hemorrhagic is applicable. A few reported cases seem to prove that varicose veins or atheromatous arteries may by rupturing give rise to serious, even fatal, hemorrhage. Enlarged prostate may also cause spontaneous bleeding.

The final determination as to the source of hæmaturia must depend upon cystoscopic examination. Practically it is only in cases of malignant growth, or possibly in those of tuberculosis, that associated symptoms fail to suggest the origin of the blood. The examination may be made either in the interval between attacks or during the course of the bleeding; if the hemorrhage is very free and from the vesical region, nothing can be seen, since the fluid injected into the bladder at once becomes opaque from admixture of blood. If the bleeding is of renal origin, by using the irrigating or evacuating cystoscope the blood may be seen escaping from the ureter. When the hemorrhage is from the kidney it is often impossible to determine the affected side unless the examination is made at the time of the bleeding.

If an examination made after bleeding has ceased shows that the bladder is healthy, this of course points to the renal origin of bleeding. If, on repeated trials, the urine previously having been nearly or quite free from blood, the introduction of the cystoscope at once occasions such free hemorrhage that examination cannot be made, this is itself indicative of the vesical origin of the hemorrhage and almost positively points to new growth.

Treatment of Hæmaturia.—During an acute attack of bleeding, whatever be its cause, rest in bed, liquid diet, preferably milk and buttermilk, and

diluent drinks, for the purpose of lessening the tendency to coagulation in the bladder, are advisable on general principles. The lower bowel should be kept empty by means of enemata.

Medication by the mouth is of little value. Guyon speaks well of turpentine. This may be given in three-drop doses hourly for six or eight hours, preferably well diluted in the form of a mucilaginous emulsion. Ergot and ergotin have been strongly commended, and may be given in full doses—a drachm of the former or five grains of the latter at hourly intervals. Oil of erigeron also seems serviceable at times—thirty drops in an emulsion repeated in one-half hour, followed by five- to ten-drop doses every two hours. Gallic acid is credited with some hæmostatic powers. It may be given in ten-grain doses every hour.

When the bleeding is profuse and persistent, injection of normal human or horse blood-serum is indicated, in doses of ten to fifty cubic centimetres. If there be tenesmus, pain, and overdistention of the bladder from clotting and urethral obstruction, a full dose of morphine should be administered and the bladder emptied by the catheter and suction syringe. This may be followed by irrigation with a hot astringent antiseptic solution, such as silver nitrate 1 to 2000, or fluid extract of hydrastis (colorless) an ounce to one pint, and the injection of a half ounce of adrenalin chloride 1 to 5000, or the same quantity of antipyrine solution, five per cent. Antipyrine possesses distinct value as an analgesic, and is credited with being a powerful hæmostatic. Continuous catheterization is indicated till the bleeding ceases. If the use of the catheter is impracticable, suprapubic cystotomy is the operation of choice, followed by the removal of clots and the insertion of a large drainage-tube.

Most minute antiseptic precautions must be observed in all these manipulations, since the urinary tract in case of bleeding is peculiarly susceptible to infection, which if once started is liable to resist treatment and extend rapidly to the kidneys. The dangers are particularly great in cases of neoplasm.

The bleeding of prostatics, dependent upon the intense engorgement which complicates retention, if profuse and threatening to life, is best treated by evacuating the blood by means of a catheter and syringe and keeping the bladder empty by the retained catheter. If the clots cannot be removed in this way, perineal or suprapubic cystotomy is indicated. If bleeding persists, pressure above the pubis, applied by means of compresses, must be tried.

Hemorrhage from prostatitis and prostatocystitis relieves engorgement. If moderate it is often benefited by balsams combined with diluents and by the rectal use of opium. The same treatment is applicable to tuberculous cystitis. Renal hemorrhage, if persistent and threatening to life, should be treated by exploratory nephrotomy. This operation is often curative even though no cause be found for the bleeding. Further detailed treatment of hæmaturia is given in the sections devoted to the pathological conditions which cause it.

Pyuria.—The presence of pus in the urine is indicative of the existence of an area of inflammation somewhere in the urogenital tract, the extent of the pyuria giving some indication of the severity of the inflammation, while by following it to its source we are surely led to the seat of trouble. The methods

whereby this is accomplished are described in the chapter on Examination of the Urine (p. 14).

Pyuria can usually be recognized by the appearance of the urine as it is examined by transmitted light; occasionally, as in cases of mild pyelitis, it is necessary to examine the centrifugalized urine with the microscope in order to detect the presence of pus cells. In such cases the pus appears in the form of separate cells.

The treatment of pyuria is necessarily that of the source, since the condition is merely a symptom of the disease.

Frequency of Urination.—Most men empty the bladder upon rising in the morning, during the after-breakfast defecation, at noon, in the late afternoon, and before going to bed, passing from six to twelve ounces of urine at each act of micturition. In warm weather urination is less frequent, the skin relieving the kidneys.

The most common causes of frequency of urination are inflammation of the bladder or of the posterior urethra, or some mechanical irritant of the bladder mucosa, as a calculus or tumor. Occasionally an unsuspected bacteriuria is found to be the etiological factor.

The bladder is said to be irritable when the desire to urinate comes too frequently. This irritability may be entirely of psychic origin—as, for instance, the frequent micturition of the student subject to examination—or it may be due to habit, though, unless the frequency be continued through the night, this does not lessen the absolute capacity of the bladder.

The irritability may also be caused by reflexes from the rectum, urethra, prostate, seminal vesicles, testicles, or kidneys.

It may be due to increased secretion on the part of the kidneys, as in diabetes. In this case the bladder is not, properly speaking, irritable, since it contains urine comfortably up to its full normal capacity, but has to be frequently emptied because it is so rapidly filled.

The treatment of frequent urination is founded on the detection and removal of the cause, and is given in the sections devoted to the consideration of cystitis, stone, stricture, cancer, etc.

There is, however, one form of frequent urination which apparently is purely functional. In the absence of urethral lesions or pathological conditions of the urine, the patient is unable to retain his water more than one or two hours at a time. The desire to urinate, if not immediately gratified, becomes irresistible. The bladder is completely emptied at each act of micturition. There is usually moderate polyuria.

This condition may be due to masturbation, may follow sexual excess or prolonged sexual excitement, or may develop without appreciable cause. It usually affects young unmarried men. In the cases we have observed from four to six ounces could be retained comfortably; efforts to retain more than this caused great distress. In one case between seven and eight ounces of clear urine of low specific gravity (1.010) were passed every one and a half hours during the day. The desire to urinate, if resisted, caused so much suffering that the patient was unable to attend dinners or any form of social entertainment which would prevent him from urinating the moment he felt

this inclination. His sleep was uninterrupted, and if his bladder was emptied immediately on rising he experienced no distress, usually passing from twelve to twenty ounces.

In deciding that this frequent micturition is purely functional it must be remembered that a similar bladder irritability is sometimes symptomatic of spinal sclerosis, particularly that form associated with exaggerated reflexes: hence bladder symptoms should always lead to an investigation as to the condition of the central nervous system. Or it may be incident to arterio-sclerosis attacking the urinary centres of the cord or the vessels of the bladder.

A bladder abnormally small from congenital formation, from long-continued nocturnal and diurnal incontinence, or from cicatricial contraction, may cause a form of frequent urination difficult to distinguish from that which is purely functional. The frequency, if due to contracted bladder, will necessarily be both nocturnal and diurnal, and a test of the vesical capacity by means of bland injections will demonstrate the nature of the affection.

The treatment of this purely functional frequency is at first mainly dietetic and hygienic. Since the desire is often not felt when the mind and body are actively engaged, riding the bicycle seems particularly serviceable, both for its direct effect and for its general influence on the health. All causes of prostatic congestion or hyperæsthesia must be removed. Sexual excess, prolonged sexual excitement, and constipation are to be avoided most carefully. Daily cold enemata of salt water (a drachm to the pint) are serviceable as means of emptying the lower bowel. Hemorrhoids should be cured, a redundant foreskin removed, varicocele relieved by a suspensory or subjected to radical operation, an abnormally small meatus enlarged; in fact, every possible cause of reflex excitability should receive attention.

The local treatment has for its object the relief of hyperæsthesia and congestion of the prostatic urethra. This is accomplished by full-sized cold steel sounds, the direct application of electricity, instillations, rectal irrigations, applications of heat or cold, and prostatic massage. The details of these methods are given in the section devoted to the treatment of impotence.

The medicinal treatment should be confined in the main to constructives, tonics, and stimulants. Potassium bromide theoretically should be serviceable, since it lessens reflex excitability. We have generally found it useless. Hyoscine and hyoscyamine in doses of from one two-hundredth to one one-hundredth of a grain thrice daily, and belladonna suppositories, each containing one-third of a grain of the extract, have given us better results than any of the many drugs commended.

It should be clearly recognized that this affection when it has been of long standing is extremely obstinate to treatment, and that cure, if it can be accomplished at all, is at the expense of months of patient, not too officious, treatment. Marriage, with its consequent regularity of sexual relations, favorably affects, or even entirely cures, this form of frequent urination.

Frequent urination due to a bladder small from conformation or because of prolonged non-retention (habit frequency) is best treated by daily progressive dilatation, accomplished by means of a fountain syringe, elevated three feet above the bladder, and a short urethral nozzle or soft-rubber

catheter. The urine is passed, and the bladder is then distended with warm sterile four per cent. boric acid solution till further injection becomes unbearable to the patient. The injected liquid is allowed to flow out slowly, and the distention is repeated. This treatment is repeated daily or every second day till from eight to twelve ounces of urine can be retained comfortably.

Hydraulic distention is absolutely inadmissible when the bladder cavity is lessened because of tuberculous involvement.

Alterations in the Stream.—Urine driven by a healthy bladder through a normal urethra should, unaided by abdominal strain, flow from the meatus in a steady twisting stream, which, if it be directed horizontally forward, should fall from three to five feet away from the vertical line of the body. When the muscular walls of the bladder are weakened, or when the urethra is obstructed, this stream is necessarily altered in volume, force, and direction. Irregularity in muscular effort or sudden blockage of the urethra breaks the continuity of the stream.

A small, forked, badly aimed, but forcible stream points to narrowing at or near the meatus.

A forcible, large stream, suddenly and for a time permanently interrupted, points to stone or other foreign body in the bladder; a stream becoming slowly smaller and less forcible, and ultimately dropping directly down from the end of the penis, points to enlargement of the prostate or to urethral stricture placed far back; it also may be due to acute congestion, chronic prostatitis, atony of the bladder, tumor formation, or extra-urethral pressure.

A stream which has become gradually small and lacking in force, and which is suddenly arrested, may be due to congested stricture, congested enlarged prostate, or impacted stone.

A fairly forcible stream which is intermittently and irregularly stopped for a moment at a time—the so-called "stuttering urination"—is due to vesical spasm, and is either a neurosis or a reflex.

CHAPTER II

EXAMINATION OF THE URINE, OF EXUDATES AND SECRETIONS, AND OF KIDNEY FUNCTION

For the purposes of the genito-urinary surgeon the urine must be examined from the standpoint of the "medical" condition of the kidneys, and from the standpoint of the recognition of surgical lesions in the urinary tract or in the communicating genital organs (Plate I and Fig. 1). For the former the examination is similar to that conducted in ordinary medical cases; for a description of the methods employed the reader is referred to text-books of clinical laboratory technique. One point, however, it is desired to emphasize, and that is the necessity of ascertaining the total quantity of urine voided in the 24 hours, and of taking this into consideration in making deductions from the findings of the laboratory examination. The average amount of urine secreted in a day is from two to three pints; an elimination of less than one pint is in itself cause for alarm.

The second portion of the examination includes the determination of the organ which is the seat of the pathological process, and the nature of the disease. The first requisite in the examination, therefore, is to ascertain from what part of the tract the elements observed are derived. This is done in part by mechanical means, by use of the "glass tests," supplemented when needful by the use of urethral and ureteral catheters, and in part by observing the character of the epithelial cells in the urinary sediment. The former method is the more accurate and valuable.

THE GLASS TESTS

The interpretation of the distribution of pathological elements in the several receptacles into which urine has been voided depends so intimately on a knowledge of the action of the muscles of the posterior urethra that a brief description of the points on which the test depends is here given. Urine is retained in the bladder by the action of muscles situated at the vesical orifice and at the lower end, or apex, of the prostate gland. The first of these, the internal vesical sphincter, is composed of involuntary fibres; the second really consists of two muscles, the external vesical sphincter (unstriated muscle) and the compressor urethræ or "cut-off muscle" (striated muscle), continuous with one another and apparently closely related in their function, and hereafter collectively called the external sphincter. The external sphincter is much more powerful than the internal. This has two results; when pus is secreted in the prostatic urethra it tends to flow backwards into the bladder, and there mingle with the urine rather than to appear at the meatus; moreover, if there is momentary relaxation of the internal sphincter and urine enters the prostatic urethra, its further progress is prevented by the external sphincter, which, stimulated by the presence of urine in the prostatic urethra, contracts strongly to repel its further advance, while with it con-

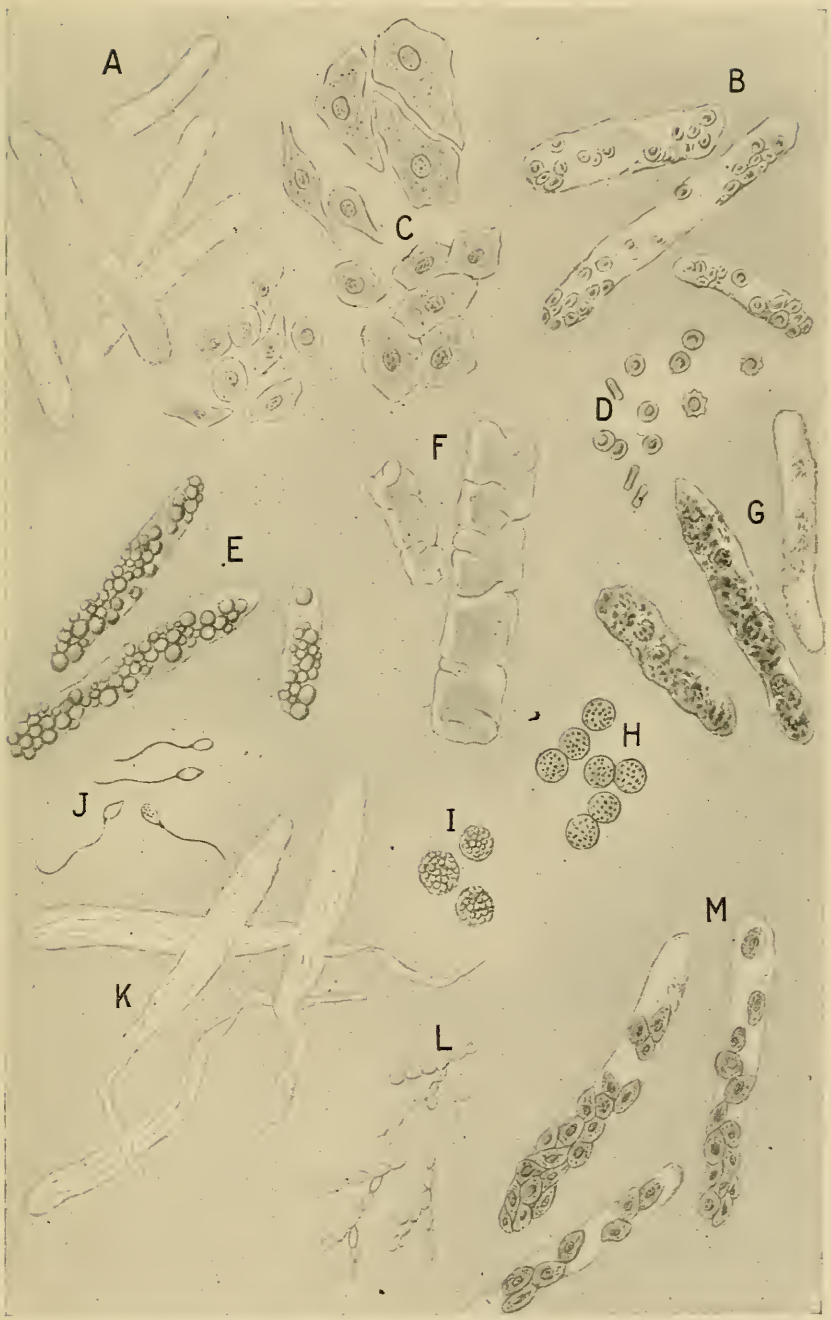


FIG. 1.—Organic urinary constituents. *A*.—Hyaline casts. *B*.—Blood-casts. *C*.—Epithelial cells (various forms). *D*.—Erythrocytes. *E*.—Fatty casts. *F*.—Waxy casts. *G*.—Light and dark granular casts. *H*.—Pus cells. *I*.—Compound granule cells (prostatic). *J*.—Spermatozoa. *K*.—Cylindroids. *L*.—Saccharomyces (yeast). *M*.—Epithelial casts.

tracts the whole musculature of the perineum, and probably also the prostate, so that the urine is forced back into the bladder, carrying with it whatever débris may lie in the part of the urethra invaded. On account of the difference in the behavior of pus formed in front of and behind the external sphincter, as well as for certain differences in the physiology of the two portions of the canal, that portion of the urethra lying in front of this sphincter is called the anterior urethra, as contrasted with the posterior urethra, that portion of the canal lying between the extenal sphincter and the bladder.

For the proper interpretation of any of the glass tests it is essential that the patient have held his urine for at least four hours prior to the examination. Tall cylinders holding about six ounces are most suitable for the reception of the urine.

Two-glass Tests.—The first glass contains the washings of the whole urethra; the second glass contains secretions from organs proximal to the external sphincter (posterior urethra, prostate, bladder, etc.). Interpretation: First glass cloudy and second clear signifies an anterior urethritis; fallacy, with very little discharge from the posterior urethra, no pus may make its way back into the bladder, and a posterior urethritis may thus escape detection. Both glasses cloudy signifies anteroposterior urethritis; fallacies, when very little urine is voided the anterior urethra may be imperfectly cleansed, and a simple anterior urethritis be mistaken for one of the whole canal, or the disease may be situated farther up the tract.

Three-glass Test.—The urine is voided in a *continuous stream* into three glasses, the last portion being passed with as much straining as possible. The first two glasses are the same as in the preceding test; the last contains, in addition to the contents of the second glass, material squeezed from the prostatic ducts by the contractions of the musculature of that body.

In order to avoid some of the fallacies incident to the tests just mentioned, several tests have been devised wherein irrigation of the anterior urethra is used to free this portion of the canal of pus and mucus. The irrigations may be performed by means of an irrigator and blunt urethral nozzle, with a hand syringe, or with a small, soft-rubber catheter or glass tube attached to a reservoir. Kollman's five-glass test is typical of this class. In it—

Glass 1 contains the washings of the anterior urethra.

Glass 2 is a control (additional washings).

Glasses 3, 4, and 5 contain urine voided in a continuous stream; glass 3 therefore contains secretions from the posterior urethra, glass 4 is a control of glasses 3 and 5, and glass 5 is the same as glass 3 of the three-glass test.

The examination of the secretions of the prostate and seminal vesicles is described in the sections devoted to those organs. (pp. 392 and 377).

The pathological secretions of a diseased bladder cannot be mechanically separated from those of the posterior urethra.

Urine from the kidneys and ureters can be collected by means of ureteral catheters introduced through a cystoscope.

"Staining" Test.—This test is useful when there is some doubt, after the performance of the other glass tests, as to the condition of the posterior urethra. The anterior urethra is irrigated as in the preceding test. With a small urethral

syringe about two drachms of a 1 per cent. solution of methylene blue or some similar stain is then injected into the anterior urethra and retained for one minute, after which it is allowed to escape and the anterior urethra irrigated for a second time, to free it from the excess of stain. The urine is then voided, sedimented, and the deposit examined with the microscope. The presence of unstained pus-cells is indicative of disease above the compressor muscle, usually of a posterior urethritis.

Cytologic Localization

Localization of the site of a lesion may sometimes be accomplished by microscopical examination of the urine. Such localization depends upon the fact that in the presence of inflammation there is always desquamation of a certain number of epithelial cells. It is only by a study of these that localization can be accomplished. The most important point to be considered in deciding from what region a given cell has come is size. There is some variation in the size of cells coming from a given region in one individual, but by selecting an average cell, and taking into consideration the character of the other cells in the specimen, it is said to be nearly always possible to correctly name the organ from which the element came (Heitzmann).

The largest epithelial cells are those from the vagina. Those coming from the most superficial layer of the vesical mucosa, either sex, are the next smaller; then come those from the cervix uteri, the urethra, the pelvis of the kidney, the ureter, the prostate, and the uriniferous tubules of the kidney. The smallest, those from the kidney tubules, are about one-third larger than the pus-corpuscles of the patient examined, so these cells are to be taken as the standard of comparison. Cells from the convoluted tubules are cuboidal (generally spherical on account of absorption of water from the urine); cells from the straight tubules are columnar. The cells from the ureters are larger, about three times the size of a pus-cell. They are spherical and morphologically identical with the cells from the interior of the prostate. The cells from the pelvis of the kidney are a little larger, usually caudate, pear-shaped, or lenticular. From the urethra the cells of the upper layer are flat and polygonal, from the deeper layers globular or columnar. The shape of the large cells from the bladder also varies according to their situation, in the same manner as do those from the urethra.

QUALITATIVE EXAMINATION

The freshly voided urine should be examined by transmitted light as to its color and clarity, the former being an indication of its concentration and of the presence or absence of blood, the latter of its relative freedom from pus, mucus, bacteria, semen, shreds of tissue, and inorganic crystalline or amorphous precipitates. The odor of the urine, whether normal, ammoniacal, or putrid, is also to be noted.

Some of the solid particles in the urine can be recognized by the naked eye, while others require chemical tests or the use of the microscope. Thus shreds which are short, thick, and sink rapidly to the bottom of the vessel are composed mainly of pus, while those which are long, thin, and float in

the upper part of the urine have a considerable amount of mucus in their composition. Of the substances which cause diffuse clouding of the urine (pus, phosphates, urates, bacteria, and semen), phosphates, with carbonates, occur in neutral or alkaline urine and disappear on the addition of an acid; pus is best demonstrated by the use of the microscope; in the vast majority of cases it is the cause of clouding in acid urine; the clouding due to urates disappears on heating the urine; the microscope is necessary to recognize bacteria or semen as the cause of clouding; amorphous phosphates and urates are indistinguishable by means of the microscope.

Hæmaturia and Hæmoglobinuria.—The presence of red blood-cells or their coloring matter, according to the amount present, affects the color of the urine not at all, or gives it a pink tinge or deep-red color. The laboratory differentiation of the two conditions depends on the finding of red blood-cells in the case of hæmaturia; if the two conditions coexist, the amount of hæmoglobin present is out of proportion to the number of blood-cells.

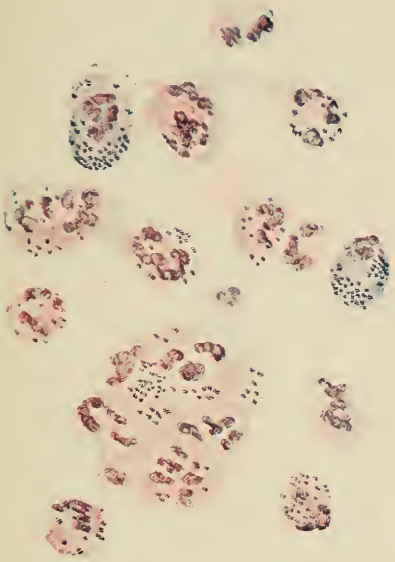
The presence of hæmoglobin or blood can be recognized by means of the spectroscope or by chemical tests. Of the latter, the most easily performed is Heller's test: A small portion of the urine, or, better, of the urinary sediment, is rendered strongly alkaline with sodium hydrate and boiled. In the presence of hæmoglobin the phosphatic precipitate which forms on standing has a bright-red color, due to the formation of hæmochromogen. If the amount of blood is very small, or there is doubt as to its presence on account of the interference of bile-coloring matter, the precipitate should be caught on filter-piper and dissolved with acetic acid, the resulting solution being red in the presence of blood-pigment, the color gradually fading on exposure to the air. The test is said to detect the presence of oxyhæmoglobin when present in the proportion of 1 to 4000.

Microscopical Examination.—The urine should be sedimented for this examination, preferably by means of a centrifuge; if a power centrifuge, either water or electric, be employed, and a definite time (*e.g.*, three minutes) be allowed for the process, the results will be most uniform.

For many examinations the sediment may be simply taken up with a pipette, placed on a slide, and examined in the fresh condition. This examination suffices to differentiate pus-, blood-, and epithelial cells. For more minute examinations, especially for the demonstration of bacteria, it is necessary that the specimens be dried, fixed, and stained. The sediment is most satisfactorily fixed to the slide by first smearing the glass with a dilute solution of egg-albumen, adding the sediment for examination when the albumen is nearly dry. The specimen is fixed, after it has become entirely dry, by passing through the flame. In most cases simply drying the sediment on the slide and passing it through the flame suffices to fix it.

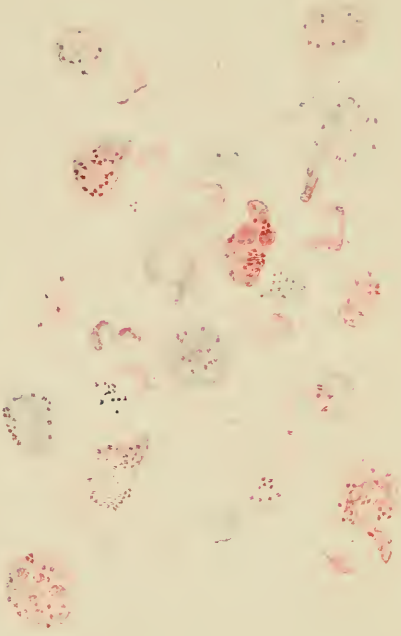
Smears of purulent secretions should be prepared in the same way as blood smears, a small drop being placed in the middle of a clean cover-glass, a second cover-glass applied so that the secretion is spread in a thin film between the two, and the films slid apart. They are then allowed to dry in the air, and passed once or twice through the flame of a Bunsen burner in order to fix them.

PLATE II.



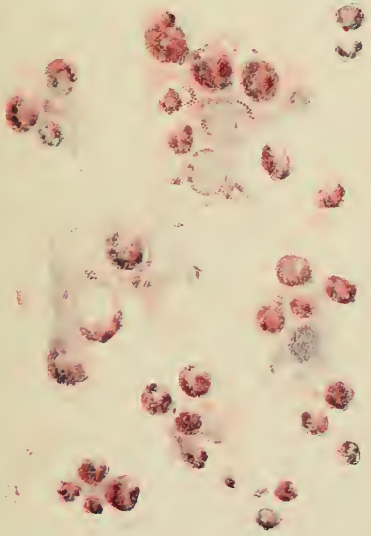
A

Pus of acute gonorrhœa (eosin-azur).



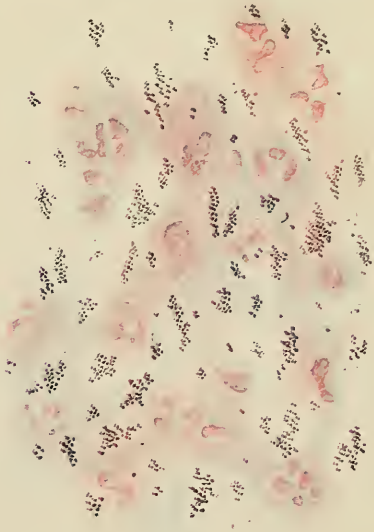
C

Pus of acute gonorrhœa with mixed infection (Gram's method, safranin counterstain).



B

Pus of "pyogenic" urethritis (eosin-azur).



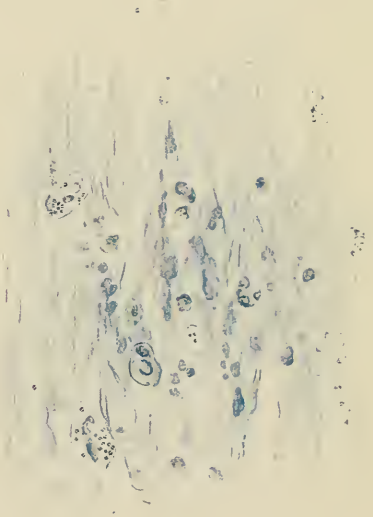
D

Pus of acute "pyogenic" urethritis (Gram's method, safranin counterstain).

PLATE III.

A

Pus of subacute gonorrhœa with mixed infection (Gram's method, Bismarck brown counterstain).



B

Shred of gleet (Loeffler's methylene blue).

Stains.—Three methods of staining are extensively used in genito-urinary investigations: simple monochromatic or bichromatic staining, staining by Gram's method, and staining acid-fast bacteria by the method of Gabbett.

For the first of these any of the following are recommended for routine use: Ehrlich's anilin methylene blue, Unna's polychrome methylene blue, Giemsa's eosin-azur (Plate II, A and B) (used also for the *Treponema pallidum*), and carbol-thionin, made up as follows:

French thionin	0.5 Gm.
Alcohol, 95 per cent.	10. c.c.
Phenol, 5 per cent.	90. c.c.

Gram's method of staining, important especially in the recognition of the gonococcus (Plate II, C and D, and Plate III, A), is performed as follows:

(*a*) Stain for three minutes, film side down, in anilin water, gentian violet (prepared by shaking 1 c.c. of anilin oil with 12 to 15 c.c. of distilled water in a test-tube, filtering through wet paper into a watch crystal, and adding saturated aqueous solution of gentian violet till the solution adhering to the sides of the glass after tipping is distinctly colored—4 to 6 drops; the stain must be prepared fresh daily).

(*b*) Shake off excess of stain, and submerge in or apply Gram's iodine solution for one minute (iodine, 1 part; potassium iodide, 2 parts; water, 300 parts; this solution must be discarded when it begins to lose its deep "iodine" color).

(*c*) Decolorize in alcohol, 95 per cent., till color ceases to come away.

(*d*) Wash in water.

(*e*) Counterstain with safranin, 20 drops of saturated watery solution to ½ ounce of water, or 1 drop of saturated alcoholic solution of fuchsin in a watch-crystal (½ ounce) of water, for ½ to 1 minute.

Acid-fast bacteria are stained by the following method:

(*a*) Apply carbol-fuchsin stain (100 c.c. of 5 per cent. phenol added to fuchsin, 1 Gm. dissolved in 10 c.c. alcohol) for five minutes.

(*b*) Decolorize and counterstain with Gabbett's solution (1 to 2 per cent. methylene blue in 25 per cent. sulphuric acid) till the red color has disappeared, or decolorize with 1 per cent. hydrochloric acid in alcohol and counterstain.

The acid-fast bacteria likely to be seen are the tubercle and smegma bacilli. They are morphologically indistinguishable; however, if the meatus be thoroughly cleansed, and a catheter be used for the collection of the urine, there is practically no danger of contamination by the smegma bacillus, so that under such circumstances the finding of a red rod in a smear is sufficient basis for the formation of a diagnosis of tuberculosis.

The search for the tubercle bacillus in urine is often a very tedious procedure. The sediments from twenty-four specimens of urine must be employed, these being further concentrated by centrifugation. The work is rendered easier by mixing the sediment with about one-fourth its volume of antiformin and allowing it to stand for twenty-four hours. All organic matter save the tubercle bacilli is thus oxidized.

Animal Inoculations.—The surest and most accurate method of demonstrating the presence of tubercle bacilli is by the inoculation of guinea-pigs. This may be done intraperitoneally or subcutaneously.

In intraperitoneal inoculation 3 to 5 c.c. of the centrifugalized urinary sediment is heated to 60° C. for ten minutes to kill pyogenic bacteria, cooled, and injected. Autopsy is performed in six weeks. This is probably the surer of the two methods.

In subcutaneous inoculation the injection is made near the inguinal lymph-nodes, which have been previously bruised with the fingers. After ten days the nodes are excised, crushed between glass slides, and stained by Gabbett's method, or examined histologically for tuberculosis.

DETERMINATION OF KIDNEY FUNCTION

Tests for the determination of the relative integrity of the kidneys are useful for three purposes: to ascertain whether the "combined" or "total function" of the two kidneys is sufficient to warrant the administration of an anæsthetic and the performance of an operation, especially an operation on the genito-urinary organs; secondly, to determine whether one of the kidneys is the seat of disease by ascertaining the comparative function of the two sides; and, thirdly, to determine whether, in the event of the removal of one kidney, the other is capable of performing the total renal function for the organism.

The requirements of the test are that it should be reasonably accurate, should be without deleterious effect upon the patient, and that its application should not be complicated. A large number of tests have been proposed. Of these, those which appear to be the most valuable are the indigocarmin test, the phenolsulphonephthalein test, the urea nitrogen and the total nonprotein nitrogen of the blood.

The interpretation of the results of the tests usually presents no difficulties. In doubtful cases it is advisable to make use of more than one test in order to get as much information as possible. Of the three tests mentioned, indigocarmin and phenolsulphonephthalein may be considered tests of renal elimination, while the blood urea nitrogen and total nonprotein are regarded as tests of retention.

When there is doubt as to the operability of a case the tests should always be repeated after the lapse of several days or weeks, during which such palliative measures as drainage of the bladder have been instituted. If subsequent tests show an improving kidney function, operation is sometimes permissible in the presence of findings which with a decreasing or stationary function would be an absolute contra-indication.

Indigocarmin.—*The indigocarmin test* is the most easily performed, and seems to be the most reliable. Its chief disadvantage, the traumatism to the tissues occasioned by the injection of 20 c.c. of fluid and the resultant soreness, can be overcome by intravenous administration.

The test is performed by injecting a solution of the drug (20 c.c. of a 0.4 per cent. solution in physiological saline) either intramuscularly or intravenously, and noting the time elapsing before its elimination, and when in doubt as to the

proper interpretation, by estimating the percentage eliminated hour by hour for three hours. When the intravenous method is used and the time of appearance only is to be determined, 4 c.c. of the 0.4 per cent. solution is a sufficient dose. It may be conveniently carried in small ampoules which have been sterilized in a water-bath after filling.

When the combined function only is desired the observations may be made with the aid of a urethral catheter, or by having the patient void at intervals when there is no residual urine. When a determination of unilateral kidney function is necessary, simple observation of the appearance of the blue at the ureteral orifices by means of a cystoscope (Plate V, *d*) is all that is is required; ureteral catheterization is neither essential nor desirable, on account of the possibility of reflex inhibition of the kidneys from the presence of the catheter. For this reason the test is applicable to cases in which the ureteral openings are visible though they cannot be catheterized, and to cases in which it is not possible to identify the orifices on account of the nature of the surrounding bladder surface without the aid of the elimination of colored urine.

The dye is sterilized by boiling in a small flask immediately before injection; when used intravenously it should also be filtered. In has no toxic properties.

From "functionally sufficient" kidneys the dye is eliminated as "dark blue" in from three to twenty minutes; occasionally elimination occurs as "light blue," in which case fifteen minutes is to be considered as the limit. The above figures have reference to the time of elimination when the injection has been made intramuscularly (the upper, outer third of the gluteal region is usually selected). When the intravenous route is employed a delay of more than seven or, at the most, ten minutes should be considered an indication of insufficiency.

In cases in which there is some doubt as to kidney sufficiency a quantitative determination should be made of the percentage excreted each hour during the first three hours after injection by means of a colorimeter. Normal kidneys excrete from 25 per cent. to 40 per cent. of the amount injected during this three-hour period; a trifle more is excreted when the intravenous route is used than when the drug is given by the intramuscular method, and a larger percentage is found in the first hour's portion. Normally the percentage eliminated in the first hour greatly exceeds that found in the third hour's specimen; namely, in the ratio of 5:1 (so-called *index of elimination*); an approximation of the two amounts, especially surpassing of the first hour's by the third hour's, should be considered as a contra-indication to operations of the severity of a prostatectomy.

Phenolsulphonephthalein was introduced to the medical profession as a means of determining kidney function by Geraghty and Rowntree in 1910. It is quite reliable as an indicator of kidney condition, and the method of its application is not complicated. It is excreted almost entirely by the kidneys, in a comparatively short space of time in normal cases. It has a beautiful red color in alkaline solution; in acid solution it has a rather deep yellow color.

One-half hour before the injection of the dye the patient should drink from 300 to 500 c.c. of water, to insure a free flow of urine. The test is performed by injecting, either intramuscularly or intravenously, 6 mg. of the dye in 1 c.c. of solution. The solution is but very slightly irritating. In normal cases elimination begins in from five to eleven minutes after intramuscular and in three to five minutes after intravenous administration. As it has been found that the onset of elimination, early or late, has a definite relationship to the rate of elimination, rapid or slow, it is the present custom to omit the determination of the former point and simply to collect the urine at the end of one hour and ten minutes and of two hours and ten minutes (ten minutes being allowed for the appearance of the dye), and to then determine the amount excreted in these periods by means of a colorimeter. The authors of the test state that from 50 per cent. to 60 per cent. of the dye injected intramuscularly is excreted by normal kidneys during the first hour, and from 60 per cent. to 80 per cent. during the first two hours; these figures are a little higher than those reported by the majority of investigators. Intravenous administration is used chiefly in determining unilateral function, as for this ureteral catheterization is necessary, and it is desirable to shorten the period of observation as much as possible. Thus given, during the first fifteen minutes of elimination from 35 per cent. to 45 per cent. is excreted, 50 per cent. to 65 per cent. during the first half hour, and 63 per cent. to 80 per cent. during the first hour; the observation is generally concluded at the end of half an hour, or at the end of fifteen minutes if the elimination is free. The ureteral catheters must collect all of the urine secreted; if this cannot be done by means of flute-tipped catheters, an occluding Garceau catheter must be used on one side, while the urine from the other side is collected transvesically.

It is difficult to state definitely in the presence of what percentage it is permissible to perform operations of a serious nature. It would seem that prostatectomy, for example, is generally contra-indicated by a two-hour elimination of 30 per cent. or less, especially if the second hour's elimination is equal to, or greater than, that of the first hour. For operations injuring or removing one of the kidneys a relatively higher percentage should be required from the opposite organ than when neither kidney is to be the subject of operative attack.

Urea Nitrogen of the Blood.—If it be necessary to supplement the results of the tests of elimination by a study of the retained products in the blood, the determination of the urea nitrogen of the blood is probably the best and most popular test of retention due to renal insufficiency. The technic employs similar apparatus and the computation is made in the same way as for non-protein nitrogen, but the method consumes less time and therefore may be preferable. Normal values lie between 10 and 15 mgm. per 100 c.c. of blood. As a rule the tests of retention closely parallel the tests of elimination. There is this alleged difference, the dye tests of excretion indicate the state of kidney function for the moment, whereas the nitrogen retention tests are a measure of the difference between the amount of waste nitrogen produced by metabolism and the amount eliminated by the kidneys. Should either of the dye tests show a low output in the urine, the result should be confirmed by one of the blood tests of retention.

Total Nonprotein Nitrogen Determination.—The determination of the amount of total nonprotein nitrogen in the blood (that is, urea and other nitrogenous elements) has not been made in a sufficiently large series of cases to establish its worth above that of the other tests described. As the examination (Folin's method is the most reliable) can be made only in a well-equipped laboratory, and there only at the expenditure of considerable trouble, the test is not likely to prove popular. However, when the determination can be made it affords evidence of about equal value to that given by the other methods described. In normal individuals the total nonprotein nitrogen of the blood, as determined by Folin's method, lies between 15 and 43 milligrammes per cubic centimetre. From 50 to 60 per cent. of this is the ammonia-urea fraction (Farr and Austin).

CHAPTER III

CHOICE, CARE, AND STERILIZATION OF INSTRUMENTS

CHOICE OF INSTRUMENTS.

For the general practitioner who desires to be so equipped that he may relieve retention of urine whether this be due to spasm, stricture, or enlarged prostate, and to recognize and treat the more common conditions encountered in office practice, the following equipment will suffice:

Catheters: Rubber, Nos. 12, 16, and 18 F.; rubber, elbowed, Nos. 16 and 18 F.; woven, elbowed, with olivary tip, Nos. 12 and 16 F.; woven, to screw on woven filiform, No. 14 F.; metal, Van Buren curve, No. 14 F.; metal, "prostatic" curve (arc of circle of 5 to 5½ inches diameter), No. 14 F.; metal, Gouley's (tunneled at tip for threading over a filiform bougie), No. 12 F.

Bougies: Filiform (whalebone) with olivary tips, ½ dozen. Bougies à boule, woven, Nos. 12, 16, and 20 F.

Sounds: Van Buren or Otis curve, Nos. 12 to 30 F. (alternate sizes).

Meatotome.

Syringes: Glass, holding ½ to 1 ounce.

Fountain syringe, or irrigator (preferably of the Valentine model).

Deep urethral instillator, No. 20 F.

Finger cots.

Lubricant.

The sizes of instruments are given according to the Charrière, or French, scale. The number indicates the circumference of the instrument in millimetres.

The genito-urinary specialist requires a more extensive equipment. Whilst each will select instruments in accordance with his habitual or occasional needs and his individual preferences, in addition to the list given as serviceable to the general practitioner, including a much larger assortment of catheters, bougies, and sounds, the following are suggested as likely to be generally helpful in both diagnosis and treatment:

Instruments Used in Examinations

Urethrometer (Otis).

Vesical stone searcher.

Urethroscopes (see Chapter IV).

Cystoscopes (see Chapter V).

Ureteral catheters, plain and impregnated with metal (radiographic, see Chapter V).

Battery or rheostat (see Chapter V).

X-ray apparatus.

Colorimeter (Duboscq or Hellige).

Dark-field substage for microscope, and illuminator for same.

If the specialist has not the facilities of an equipped laboratory, he may also need in his examination a colorimeter, a spectroscope, and a polariscope.

Instruments Used in Routine or Special Treatment

Flexible shot-filled bougies, Nos. 10 to 20 F.
Kollmann dilator, with blades for the anterior and posterior urethra.
Rectal electrode.
Faradic and galvanic batteries.
Ointment depositors.
Apparatus for intravenous medication.
Syringes of various sizes (all-glass or glass-and-metal hypodermic syringes, syringes for injecting considerable quantities of fluid (*e.g.*, salvarsan and indigo-carmin), syringes for filling the bladder).
Knives, scissors, forceps, and electrodes for use through urethroscope.
High-frequency machine.

Instruments for Operative Treatment

Urethrotomes (Maisonneuve and Gerster, see Chapter XIII).
Urethral staffs (grooved on convexity and side).
Gorget (Teale's).
Prostatectomy retractors and forceps (Young's and Thomas's).
Prostatic punch (Young's).
Prostatic incisor (galvanocautery).
Stone forceps.
Stone scoop.
Lithotrites.
Bigelow's evacuator.
Clamps for renal pedicle.
Usual operating instruments.

The soft-rubber catheters must be smooth, strong, elastic, and not too flexible. The ends should be slightly conical (Fig. 2), though with a distinctly rounded extremity, rather than hemispherical; the elbowed extremity is particularly desirable in prostatic cases. They are the instruments of choice

FIG. 2.—Cylindrical catheter.

when the bladder is to be either emptied or filled, since they are the least traumatizing of all urethral instruments. Loss of elasticity or smoothness is an indication for rejection.

Elbowed woven catheters are, in cases of prostatic obstruction, easier of introduction than are similar catheters which are straight; an olivary tip still further facilitates their passage (Fig. 3). Very narrow strictures are best passed by a straight woven catheter screwing into a woven or whip filiform bougie (Fig. 4). A woven catheter which has lost its surface should be rejected.

The eyes of metal catheters should exhibit margins so smooth and depressed that the urethral mucosa cannot be traumatized thereby.

The lip of the lumen of a Gouley's catheter must be smooth to avoid cutting either the urethra or the filiform, and the aperture must allow free passage of any of the filiform bougies used in passing a tight stricture.

The filiform bougies should be of exactly equal length, free from splits or cracks, and should be capable of holding an angle made by bending over the thumb-nail without exhibiting any surface break or roughening.

Bougies à boule of linen or silk web, with abrupt, sharp-edged shoulders, are the best. Metal instruments of similar shape are more durable and are more readily sterilized. A urethrometer (Fig. 5) satisfactorily replaces these intruments.

Sounds should have smooth, untarnished surfaces, with a taper which reaches full calibre before the termination of the curved portion.

A glass container should be used for urethral irrigations, etc., since failure to keep it clean can be readily detected and the flow of its contents can be

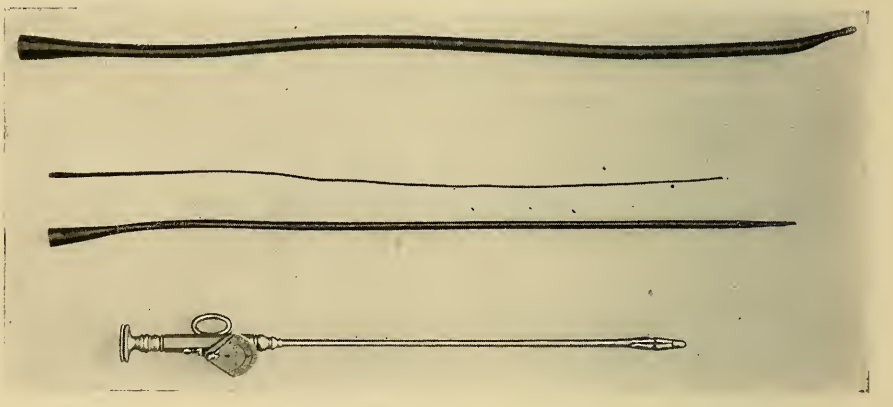


Fig. 3.—Elbowed olivary catheter.
Fig. 4.—Phillips catheter.
Fig. 5.—Otis urethrometer.

observed. The Valentine handle for manipulating the urethral nozzle and controlling the flow of the fluid is convenient.

Deep urethral instillators, catheter-like tubes with very small lumens, threaded to screw on a hypodermic syringe, are least traumatizing when of intermediate size. They are used for depositing small quantities of fluid in the posterior urethra.

Each batch of finger cots should be tested before purchase. They should be long enough to completely cover the finger, strong, and of suitable size.

The most satisfactory lubricants are water-soluble. Many such are on the market, having as a base substances such as Iceland moss, gum tragacanth, and quince seeds.

Bougies, woven, filled with fine shot to within one or one and a half inches of their tips, particularly useful in the dilatation of small strictures, should exhibit extremely flexible tips, that they may easily follow an aberrant passage through a stricture.

Kollmann's dilators (Figs. 6 and 7), now made with a universal handle, designed to treat the anterior and posterior portions of the urethra separately, are more useful than the models designed for the simultaneous treatment of both portions. Their rubber covers should be large enough to slip on easily, and strong enough not to break.

Rectal electrodes for prostatic treatment should have uncovered metal

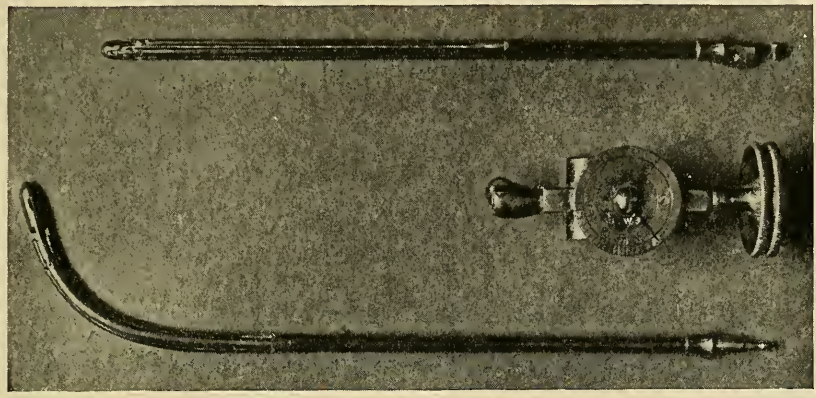


Fig. 6.—Kollmann anterior and posterior dilators, with universal handle.

on the anterior surface only; electrodes of other forms (Fig. 8) may be modified by dipping them into melted paraffin, the wax being scraped off at the desired point.

Urethral ointment depositors (anterior) are made in the form of cones (Fig. 9) to screw on collapsible tubes in which the ointment is dispensed. For

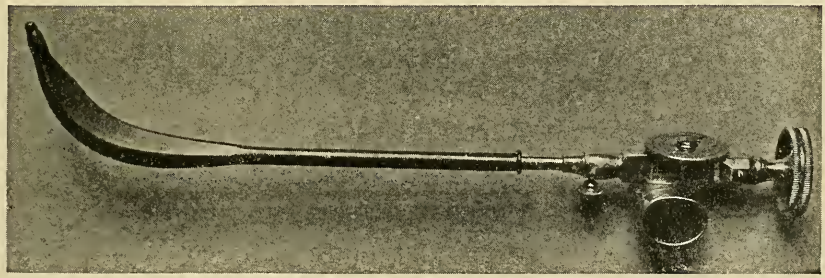


Fig. 7.—Kollmann dilator, with cover applied.

posterior applications an instrument with a long curved nozzle must be used; means must be provided, as a threaded plunger, for forcing the ointment through the narrow lumen of the tube (Fig. 10).

Intravenous medication should be administered with the simplest apparatus compatible with efficiency and safety. A burette, four feet of rubber tubing, and a needle are required, the tube ending in a teat which exactly fits the needle, and being provided with an occlusion catch (Fig. 11). A bubble-catcher in

the tube close to the needle, a stopcock in the burette, and a stopcock needle to which the rubber tubing is firmly attached are usual modifications of this simple apparatus.

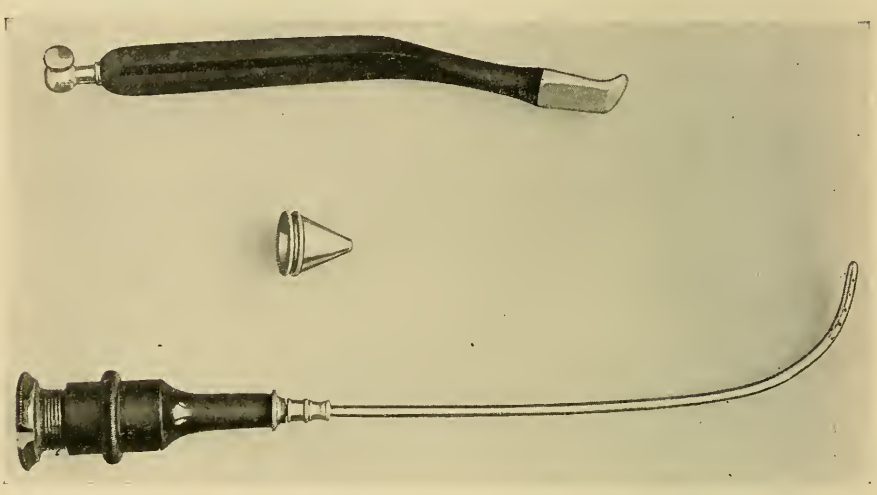


FIG. 8.—Rectal electrode.
FIG. 9.—Anterior ointment depositor.
FIG. 10.—Posterior ointment depositor.

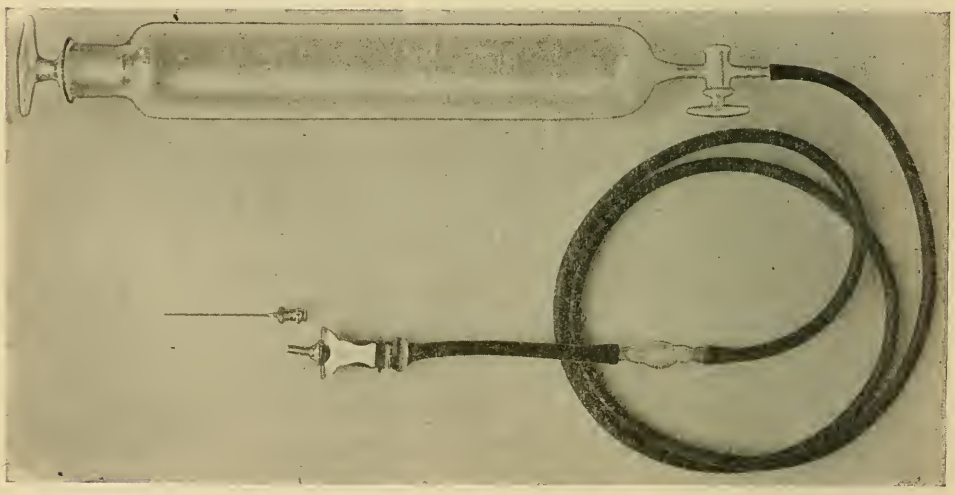


FIG. 11.—Intravenous apparatus.

Examining and Operating Table.—The special manipulations for which a genito-urinary surgeon's table should be adapted are cystoscopy and urethroscopy; otherwise all necessary procedures can be performed on any of the standard makes of tables. For cystoscopy, however, it is convenient to have the table 36 inches high (Fig. 12), fitted with a drawer for the reception of

irrigation fluid, etc., and to have stirrups arranged to hold the patient's extremities securely and comfortably in the most advantageous position; *i.e.*, with the knees about eight inches above the level of the buttocks and the legs

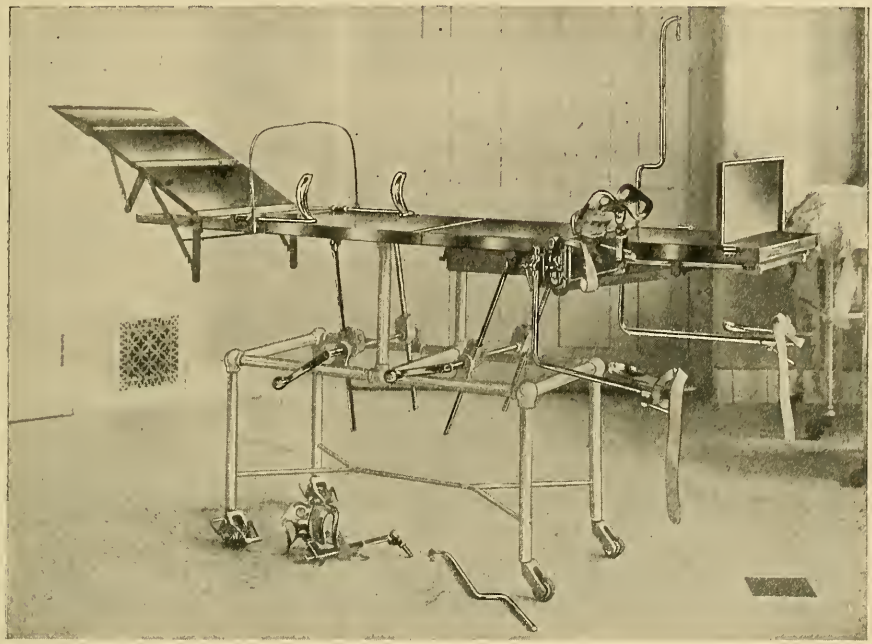


FIG. 12.—Manhattan table, modified for cystoscopy by the addition of a waste-solution drawer, and suitable supports for the lower extremities.

and feet directed toward the floor (see Fig. 25 in Chapter V). This may be accomplished either by means of supports under the knees or by means of foot-pieces.

STERILIZATION OF INSTRUMENTS

Instruments composed entirely of metal or of soft rubber can be sterilized without injury by boiling for from one to three minutes in water, or, better, since this prevents tarnishing, in sodium carbonate solution (2 per cent.); this applies to edged instruments as well as to others. Implements made entirely of glass can usually be boiled without breaking, especially if the glass be thin and the articles be completely submerged. Glass of varying thickness may be boiled if submerged in cold or lukewarm water before putting over the fire. A sudden change from cold to hot is less harmful than a similar change in temperature in the opposite direction. Articles composed of more than one part, whether of metal or glass, in which the fitting is exceedingly close, must be taken apart before boiling to avoid distortion or breakage.

Instruments composed of both glass and metal, as some syringes, may be boiled, provided heat is applied gradually.

Though woven instruments of the best grades can be boiled a few times without injury, these instruments and cystoscopes are better sterilized just

before use by means of cold antiseptic solutions or by formaldehyde gas. For general purposes a 5 per cent. solution of liquor formaldehyde, applied for ten to fifteen minutes, is the best. It is essential that the solution come in contact with every part of the instruments, and it is therefore necessary to force it through small openings by means of a syringe. For cystoscopes and similar instruments solutions of phenol (5 per cent.) or one of the cresols (2 per cent.) may be employed, but these substances are ruinous to the surface of woven instruments.

Formaldehyde gas may be derived from the official solution, or from tablets, either by allowing them to simply evaporate or decompose in the air, or more rapidly by the application of heat. At least twenty-four hours should be allowed for the gas to act, and in the case of instruments with small lumens, as ureteral catheters, even more time is necessary. The method is particularly applicable to the sterilization of urethral catheters, that they may be ready for immediate use. A number of "catheterostats" for the storing of catheters in the presence of formaldehyde are on the market. The method is specially useful for patients who have to catheterize themselves several times a day. By having sufficient catheters on hand to last two days, and placing them in two receptacles containing formaldehyde vapor, a sterile catheter is always ready for use. Aside from the time needed, the chief disadvantage of the method is the fact that unless the catheters are exposed to the air for some hours or are washed with water or boric solution sufficient formaldehyde adheres to them to cause urethral irritation.

CARE OF INSTRUMENTS

Since it is essential that urethral instruments should be perfectly smooth, it is necessary to keep their protective covering, nickel or varnish, unimpaired; hence metal instruments should not be knocked together at any time. This is best prevented by storing the instruments in drawers so shallow that but one layer is easily contained; in the case of sounds and bougies, it is a convenience to have a wooden or metal rack, that each may have its place and be easily found.

Woven and soft-rubber instruments may be kept in contact with one another in long, narrow boxes if dusted with powdered talc; otherwise they are apt to adhere.

Cystoscopes are best kept in their respective boxes.

All instruments, of whatever texture, should be cleansed with soap and water immediately after use, sterilized, and carefully dried. Tubular instruments large enough to permit the passage of cotton swabs should be washed and dried in this manner; those too small for such manipulations should have water forced through them, and should then be dried by means of air from a pump. In the case of such metal instruments as cystoscopes, after their sterilization in 5 per cent. formaldehyde for fifteen minutes, drying may be facilitated by means of alcohol and ether. The bearings and joints of all instruments should always be lubricated with sterile machine oil after each operation; the life of steel needles is greatly prolonged by a similar application.

CHAPTER IV

URETHROSCOPY

THANKS to the excellence of the modern urethroscopes the visual examination of the urethra is now accomplished with but little discomfort to the patient or trouble to the physician. This is particularly true of the anterior portion of the canal, which can be inspected with so little traumatism that it should constitute a part of the routine examination of cases of chronic urethritis. Posterior urethroscopy is more difficult, more likely to be followed by complicating traumatic inflammation and requires the use of special urethroscopes; hence it is less frequently employed.

ANTERIOR URETHROSCOPY

Instruments.—The popular anterior urethroscopes are straight tubes, usually 24 or 28 F. calibre, fitted with obturators to facilitate their introduction, and provided with electric lamps mounted on long light-carriers whereby the source of light is brought close to the surface which is being inspected; in some instruments, notably Young's urethroscope, the light is directed down the tube from without. The advantage of the former arrangement is that the illumination is somewhat more brilliant and that the light is not apt to be displaced unintentionally; of the latter that the lamp cannot become soiled by blood or other fluid welling up into the urethroscope; the former type is therefore better suited to simple examinations, and the latter to operative work.

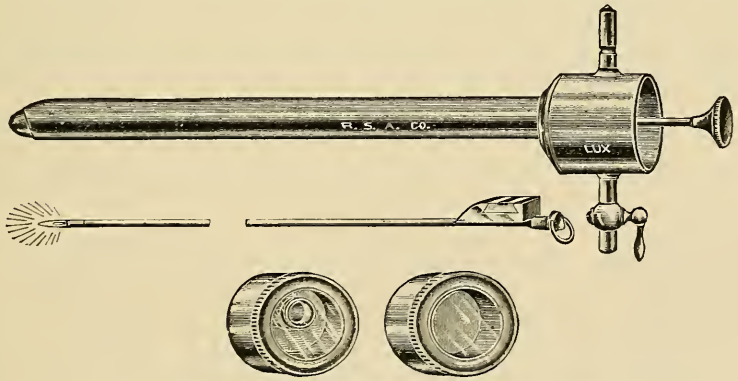


FIG. 13.—Mark's anterior urethroscope, consisting of urethroscopic tube, universal head (marked LUX), obturator, light carrier, and operating and examining windows.

Mark's urethroscope (Fig. 13) is the one most generally useful for anterior examination. It is so constructed that the air-distended urethra can be inspected through a glass window which closes the outer end of the instrument; on removing the window the instrument can be used as an ordinary urethroscope.

If needful, applications can be made to the distended urethra by inserting the applicators, etc., through a rubber nipple in the operating window.

Technique of Examination.—In addition to the urethroscopes, with at least two working lamps for each, a proved reliable source of electricity, and lubricant, at least a dozen wooden applicators barbed at the end and so wrapped with cotton as readily to pass through the lumen of the instrument should be in readiness (see Fig. 14). The patient may be lying flat on his back, or in the cystoscopic position (see p. 36). Before introducing the urethroscope the external meatus, preferably the whole penis, should be cleansed with soap and water and a solution of bichloride of mercury, and the anterior urethra should be irrigated with normal saline solution.

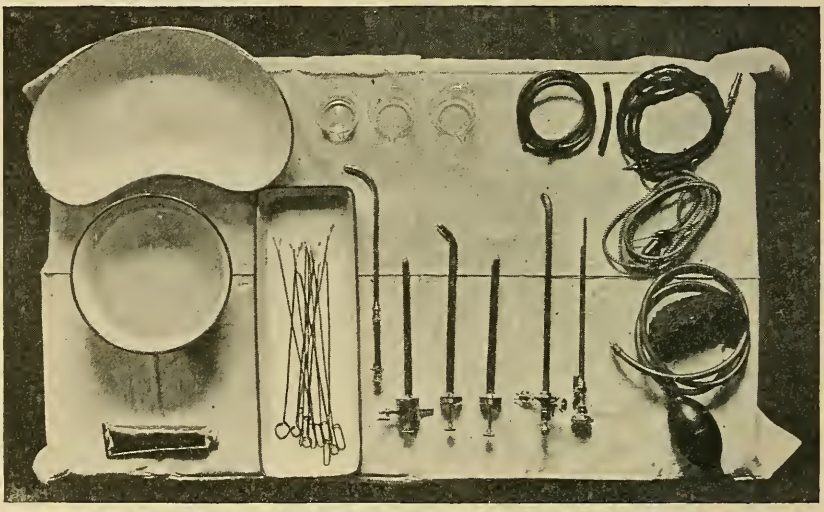


FIG. 14.—Table arranged for urethroscopic examination. On the farther side of the table are a basin for used instruments, a beaker containing eucain solution, 2 empty beakers to hold solutions for topical application, rubber tubing for the Buerger urethroscope, and conducting cords for battery attachment. On the nearer side are a basin of bichloride solution, a tube of lubricant, wire applicators tipped with cotton, a deep urethral instillator, a Mark urethroscope with 2 anterior and 1 posterior tube, a Buerger posterior urethroscope, and a bulb attachment to produce air dilatation with the Mark instrument.

After testing the electric lamp and ascertaining the amount of current necessary to secure the requisite illumination, the obturator is placed in the tube selected (the largest that will easily pass into the urethra), it and the tube are sparingly lubricated, and the instrument is introduced down to the bulbomembranous juncture by pressing on the handle of the obturator. Then, steadying the hand holding the tube by resting the wrist on the patient's thigh, the obturator is gently withdrawn with the free hand, rapid removal being avoided lest suction be produced. Any moisture present at the end of the tube is now removed with cotton; the lamp, if not already in place, is introduced, and the current turned on.

The mucosa is inspected while slowly withdrawing the tube, pressing the end now against one side of the urethra, now against another, to more fully

PLATE IV.

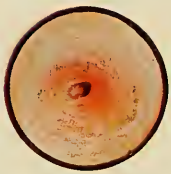
A

Diverticulum of urethra (epithelialized false passage).

B

Chronic urethritis.

C

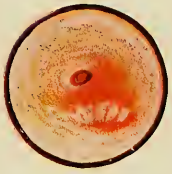


Normal anterior urethra (air distention).

D

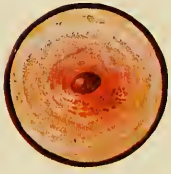
Normal verumontanum.

E



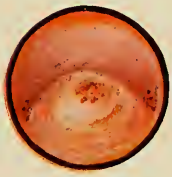
Papilloma of urethra.

F



Granular patch of chronic urethritis.

G



Enlarged verumontanum displaying utriculus on summit, preceded by orifices of ejaculatory ducts; on each side the orifices of the prostatic ducts are visible.

H

Cicatrization in chronic granular urethritis.

I

Stricture of anterior urethra (subacute urethritis).

inspect individual portions. If it should become necessary to reinspect a portion after it has passed out of the range of vision, the obturator must be inserted before the tube is pushed farther in, as otherwise the edge of the tube would traumatize the mucosa. When air dilatation is used reinsertion of the obturator is unnecessary, as the urethra can be ballooned out sufficiently to permit passage of the open tube without damage; if the meatus be large it is even possible to introduce the instrument without making use of the obturator at all.

Appearance of the Anterior Urethra.—The color of the mucosa in the anterior urethra varies from a rather bright red in the bulbous portion of the canal to a much lighter shade in the portions nearer the meatus (see Plate IV,

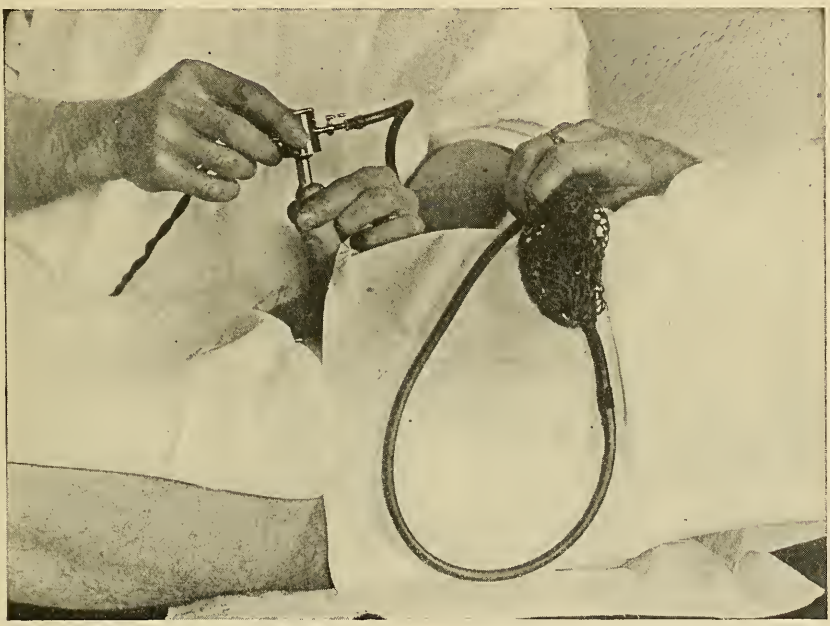


FIG. 15.—Anterior urethroscopy with the Mark instrument. The penis is held snugly about the instrument by the thumb and forefinger of the operator's left hand to prevent the escape of air passed in through the instrument from the bulb held by the patient.

Chapter I). At the margins of the field there is blanching from emptying of the tissues of blood incident to pressure of the tube.

The surface of the mucosa should be moist and glistening. The portion seen at the end of a simple urethroscopic tube held exactly in the centre of the urethra has the shape of a shallow funnel, the dimple in the centre representing the continuation of the urethral canal. This is known as the "central figure of the urethra," and its appearance is an indication of the condition of the tissues of the urethral walls. Normally the funnel is very shallow, and the mucosa is thrown into from eight to sixteen radiant striæ by the action of the surrounding tissues, pressing the walls together. When from any cause the mucosa and submucosa become thickened, there is a reduction in the number

of striæ and a corresponding increase in their breadth. Under such circumstances, also, the funnel becomes deepened, especially when traction is made on the glans, the urethra sometimes standing open for an inch or more. Throughout the greater part of its course the anterior and posterior walls of the urethra are in apposition, the only exception being in that part lying within the glans where the lateral walls are in contact. In the central figure the walls do not, therefore, come together in a point, but rather in a furrow so short that it is difficult or impossible to tell its direction.

In health the glands of the urethra are not visible, but the mouths of the follicles of Morgagni can be seen as small red points, slightly deeper in hue than the surrounding mucosa, ranged along the dorsal wall of the urethra. They neither gape open nor stand up above the surrounding mucosa.

With air dilatation, the patient manipulating the inflating bulb in the absence of an assistant (Fig. 15), the picture is greatly altered. The central figure disappears entirely, being replaced by a long, open tube whose walls become gradually approximated in the region of the bulbomembranous juncture. No striæ are present, but instead the walls are seen approximately in the condition present during the passage of urine. The lustre is the same as seen with the simple tube, but on account of the angle at which the light is shed upon the walls it appears somewhat less. The color varies greatly with the pressure of the air, it being possible to drive out the greater part of the blood so that an actively inflamed mucosa may appear paler than normal. For this reason it is advisable to use varying degrees of dilatation, and to conclude the examination by passing the instrument back into the bulb and removing the window to examine the urethra during the withdrawal of the instrument as through a simple urethroscope.

Pathological Changes in the Anterior Urethra.—Changes in the mucosa, its glands, and in the submucous tissues, and new growths may be recognized with the urethroscope. The mucosa may be redder or paler than normal, the former in acute or subacute inflammation, and the latter in chronic conditions, especially in the presence of submucous infiltrations. Inflammation of the glands and follicles is indicated by red or yellow points on the mucosa, or by distinct bulging from accumulation of secretions. Granular patches and ulcers are not common lesions. Care must be taken, when using simple urethroscopes, not to mistake the bulging of the normal mucosa of the bulb for the former condition. When present they are best recognized and treated through the urethroscope. Infiltration of the "soft" variety is indicated by a somewhat darker color of the mucosa, by a diminution of the lustre of the surface, and by a reduction in the number of striæ in the central figure. As the process progresses the development of fibrous tissue and its contraction gradually reduce the vascularity of the region, and finally lessen the calibre of the canal so that a stricture is formed. With a simple urethroscope this can only be appreciated when it has advanced so far that it interferes with the passage of the instrument, but with the air-dilating type the slightest narrowing can be readily noted. New-growths, chiefly benign, are occasionally encountered, as are calculi and various foreign bodies introduced into the urethra.

POSTERIOR URETHROSCOPY

Instruments.—A painful and traumatizing examination of the posterior urethra may be made with the straight tubes used for the anterior urethra. To a less degree this holds true of tubes with short curved ends, having openings at the convexity or heel, the so-called Swinburne tubes. These should be reserved for applications (Fig. 16).

The best instruments for visual examination of the posterior urethra are the cysto-urethroscope of Buerger (Fig. 17), McCarthy's urethroscope, and the

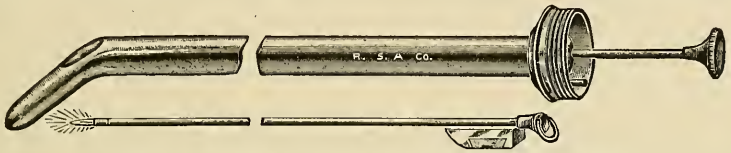


FIG. 16.—Mark's posterior urethroscope (Swinburne tube).

Acmi cystoscope manufactured by the Wappler Company. Of these instruments, the two latter have larger fields of vision, but the first is least traumatizing, having a much smaller fenestra, and is the one of choice. These instruments contain lens systems, and are used with water dilatation.

Technique of Posterior Urethroscopy (Fig. 18).—When one of the water distention urethroscopes is used, a reservoir with boric acid or normal saline solution must be provided, with small calibre rubber tubing to connect it with

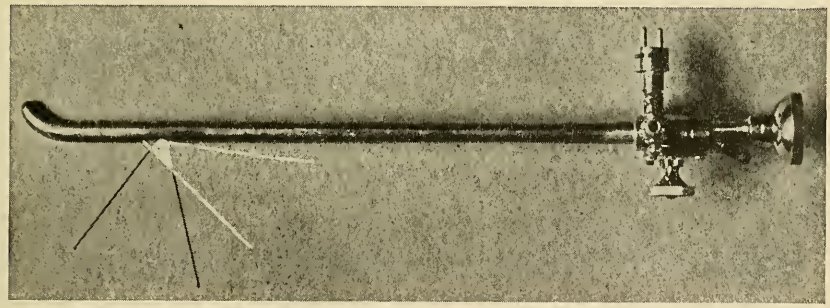


FIG. 17.—Buerger's cysto-urethroscope. The white lines mark the limits of direct illumination, while the dark lines show the boundaries of the visual field. Practically the field of vision is limited to the white area.

the urethroscope. The position of the patient is the same as for cystoscopy (Figs. 18 and 25).

Five minutes before beginning the examination the posterior urethra should be anæsthetized by an instillation of a drachm or more of 4 per cent. eucain or novocaine. After this, the amount of electricity needed for the lamp having been ascertained, and the lenses cleaned with a piece of dry gauze, the instrument is introduced into the bladder, the contents of this organ are evacuated, and its interior washed through the sheath of the urethroscope, the lens system is introduced, the electrical connections are made, the irrigating fluid is started

flowing from the reservoir, and the examination is begun. The fluid is allowed to flow throughout the examination.

Appearance of the Posterior Urethra.—The examination is begun by observing the contour of the vesical orifice by rotating the instrument at the point where the field is bisected by the internal sphincter. Normally the orifice has an even curve, but enlargements of the prostate may cause marked alterations in its contour (see Chapter V). The mucosa of the posterior urethra is more vascular than that of either the bladder or the anterior urethra. The roof and lateral walls exhibit no noteworthy features; however, they may be the site of pathological lesions, and consequently should be the subjects of routine examination.

The floor of the prostatic urethra is a little redder than the lateral walls

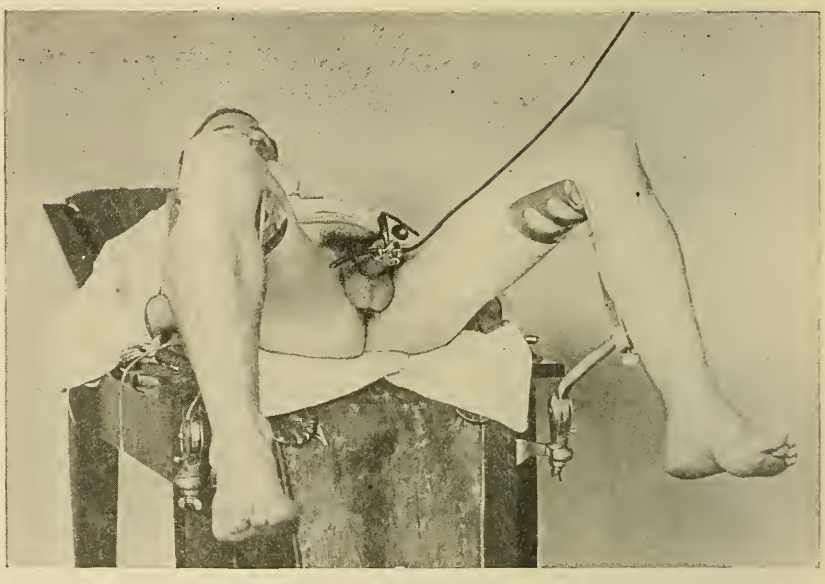


FIG. 18.—Posterior urethroscopy. Buerger instrument inserted, with tube leading to reservoir, and short tube attached for directing fluid to bucket below.

and roof, and contains the urethral crests culminating in the verumontanum. The crests are small ridges which begin sometimes on the floor of the trigonum close to the sphincter, or more often in the urethra. They are from two to five in number, and finally unite at the base of the verumontanum. This, the most prominent feature of the region, contains at its summit the sinus pocularis, on the lips of which are situated the orifices of the ejaculatory ducts, while in the sulcus at each side are the openings of the majority of the prostatic ducts. Usually the surface of the verumontanum is smooth, but occasionally it is irregular or bossed even in normal cases; it varies considerably in size.

The examination of certain parts of the urethra, as the sulci at the sides of the verumontanum, is sometimes facilitated by stopping the flow of the irrigating fluid, or even allowing a portion of it to flow out through one of the cocks, thereby causing the mucosa to approach the lens.

Pathological Changes in the Posterior Urethra.—The floor and the roof of the posterior urethra seem to be affected oftener than the lateral walls. In the presence of a considerable degree of inflammation the mucosa is redder than normal, and frequently appears roughened; occasionally there is a distinctly granular appearance. Flakes of pus are often seen adhering to the orifices of the follicles. Sometimes only the terminal results of inflammation are to be seen, causing more or less distortion, especially of the verumontanum. Occasionally small cysts or papillomata are found in this portion of the urethra. These may be either single or multiple. Hypertrophy of the verumontanum is sometimes so great that it is to be considered a pathological lesion. In making such a diagnosis the changes in size incident to erection of this organ are to be borne in mind.

TOPICAL APPLICATIONS AND OPERATIONS

These are most easily performed through one of the simple tube urethroscopes, either with or without air dilatation. In the latter case the tissues are somewhat steadied by being put on a stretch, and there is a reduction in the amount of hemorrhage. The medicament most used in topical applications is silver nitrate, either as a strong solution or in the solid form.

Operative procedures may be performed with knife, scissors, rongeur, cautery,

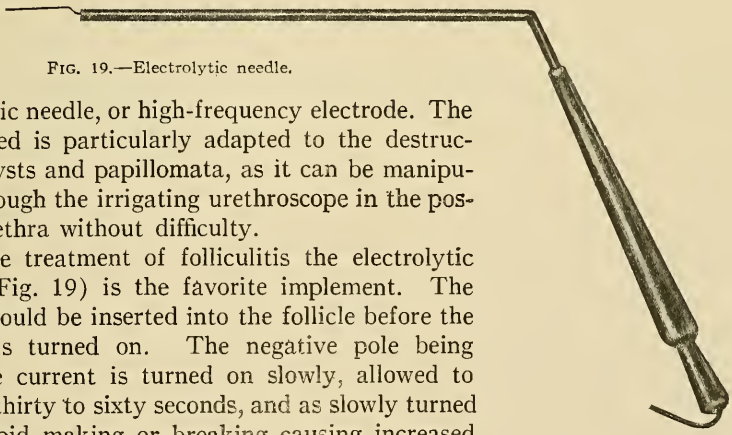


Fig. 19.—Electrolytic needle.

electrolytic needle, or high-frequency electrode. The last named is particularly adapted to the destruction of cysts and papillomata, as it can be manipulated through the irrigating urethroscope in the posterior urethra without difficulty.

In the treatment of folliculitis the electrolytic needle (Fig. 19) is the favorite implement. The needle should be inserted into the follicle before the current is turned on. The negative pole being used, the current is turned on slowly, allowed to flow for thirty to sixty seconds, and as slowly turned off, a rapid making or breaking causing increased discomfort. About five milliampères are necessary.

Slitting up infected follicles with a knife is a less effective method of treating the same condition. The cutting must be done at one stroke with a thin-bladed, sharp knife, as the bleeding from the first incision is usually sufficient to obscure the field of operation.

CHAPTER V

CYSTOSCOPY

In addition to simple inspection of the urinary bladder it is convenient to include under the caption Cystoscopy all those procedures into which the cystoscope enters as an integral factor. The present chapter will therefore deal also with such subjects as ureteral catheterization, pelvic lavage, pyelography, and certain methods of treatment of intravesical lesions.

CYSTOSCOPES

The simplest cystoscopes consist of straight tubes, through which the bladder is inspected through an air (Kelly) or water (Braasch) medium. In other cystoscopes the examination is made through an optical system consisting of a series of lenses whereby a wider and clearer view is obtained of the interior of the bladder.

Of the cystoscopes employing an optical system there are two varieties, the direct (in which the field of vision is in the axis of the instrument) and the indirect (in which the rays enter the instrument through a window in its side, being deflected to the ocular by means of a prism); some of the cystoscopes of the latter type are so constructed that retrograde vision is attained by means of a movable prism, but the addition is rarely of advantage. In the older, indirect cystoscopes the image is inverted, while in the newer instruments the natural relations are maintained, wherefore they are spoken of as having "corrected vision;" in neither types are the sides of the image transposed. For most purposes a cystoscope provided with an indirect vision lens system is the most useful.

A further advance in the construction of cystoscopes consists in the incorporation of means for the easy renewal of the fluid contained in the bladder. "Irrigation" cystoscopes are designed to permit constant change of fluid during the progress of the examination; the desired result is not attained on account of the imperfect diffusion of the fresh fluid. "Evacuation" cystoscopes are so constructed that the lens system can be removed, leaving the sheath in place to act as a large-sized catheter for the rapid emptying and filling of the bladder; with these instruments then the bladder can be thoroughly cleansed and refilled in a few moments.

The most serviceable type of cystoscope has provision for both irrigation and evacuation; in such an one the lens system can be removed for cleansing of the bladder, replaced, and the bladder filled through one of the cocks provided for the control of the irrigation, this being more readily accomplished than by the simple evacuating type of instrument. The only advantage of a fixed optical system over the removable type as seen in the evacuating cystoscopes is that it is possible to make such an instrument of smaller calibre. Cystoscopes range in size from 12 F. to 26 F.; the usual size of a cystoscope with provision for catheterization of the ureters is 24 F.

Operative Cystoscopes.—Of the many ingenious devices allowing of intravesical treatment, including snares, cutting instruments, and divulsors, Young's cystoscopic rongeur is likely to prove of most service. It is adapted to the removal of small calculi and other foreign bodies, as well as to the biting off of intravesical growths. In view of the excellent results obtained by high-frequency desiccation, the excision of vesical papillomata, even for diagnostic purposes, is not advisable.

Choice of Instruments.—The following points should be considered in the selection of a cystoscope:

A lens system which gives a clear view of the bladder wall without undue loss of illumination.

A lamp of the "cold" type, so placed in the instrument that its rays fall directly on the whole field of vision, the metal casing of the lamp hiding no portion of the filament. It is also important that the lamp be as large as possible.

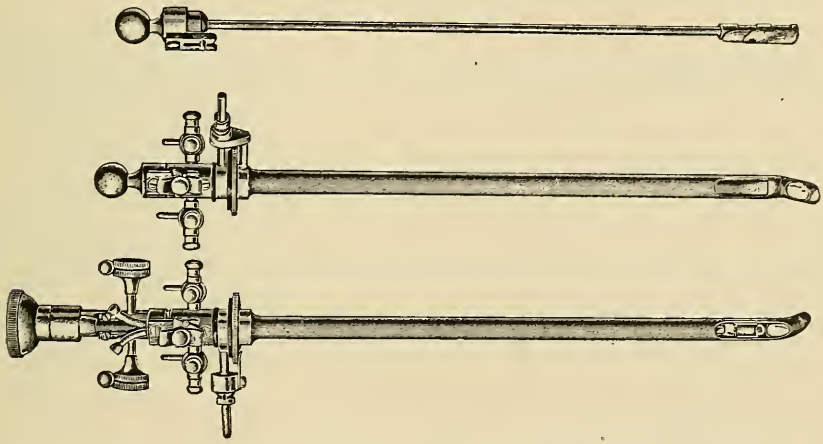


FIG. 20.—Brown-Buerger cystoscope; showing convex sheath with catheterizing telescope in position, concave sheath with obturator in place, and obturator.

A smooth, even surface, that the introduction of the instrument may cause little discomfort.

Simple, durable construction, that the instrument may be easily cared for and may not require frequent repair.

The number and type of cystoscopes required vary with the needs of the individual surgeon; unfortunately it is not possible to fill every requirement with a single instrument. The instruments mentioned below are placed in the order of their importance to the average surgeon specializing in genito-urinary work.

1. A double catheterizing cystoscope, such as the Brown-Buerger (Fig. 20) or the F. Tilden Brown (Fig. 21) instruments. The latter is supplied with both direct and indirect vision telescopes.

2. A simple examining cystoscope of small calibre, such as the Acmi 13 F., or the Otis Brown, 15 F. (Fig. 22), "examining and irrigating cystoscopes" (evacuation type).

3. A cystoscope capable of transmitting a Garceau 11 F. dilating ureteral catheter, or other flexible instrument of similar calibre, such as Buerger's convex operating cystoscope (Fig. 23); as this instrument has its lamp in the heel of the instrument it is possible to bring the lens very close to the bladder wall, and so

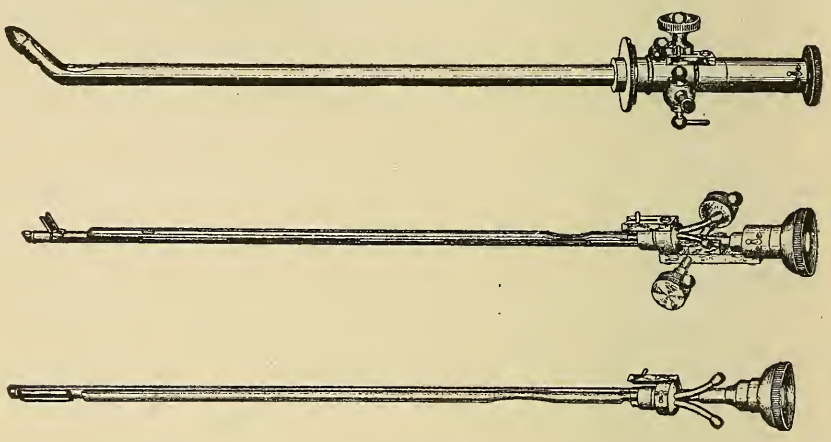


FIG. 21.—F. Tilden Brown composite cystoscope; showing sheath obturated by the indirect examining telescope, and the indirect and direct catheterizing telescopes.

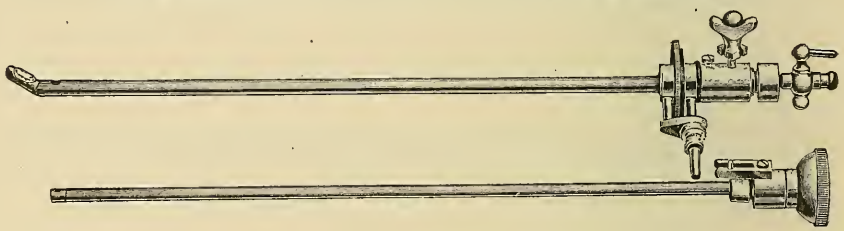


Fig. 22.—Otis Brown examining cystoscope.

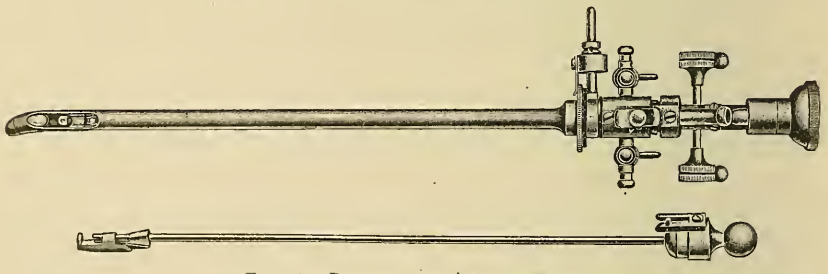


FIG. 23.—Buerger operating cystoscope.

to examine and operate in contracted bladders; the instrument can also be used in the posterior urethra.

All of the instruments mentioned above are so constructed that the bladder can be quickly evacuated by withdrawal of the optical system. Collectively they fill nearly all the requirements of the genito-urinary surgeon; if it is desired to increase the armamentarium, this can be done by adding instruments of

different calibres, aerocystoscopes, operating cystoscopes of other patterns, photographic attachments, etc.

Electrical Supply.—The current for the illumination of cystoscopic lamps may be derived from the regular street current by means of suitable reducers and controllers, from dry cell batteries, or from storage batteries. The first method is the most convenient and economical. Its disadvantages are that it is not always available; there is some danger of grounding, with resultant mild shocks to the patient or operator, and in case the current is also used for operating dynamos (for elevators, etc.) it is subject to annoying variations, sometimes decreasing to a point at which the illumination is unsatisfactory, sometimes increasing sufficiently to burn out the lamp in the midst of the examination.

Storage batteries are convenient for office use in the absence of connection with the street current. Their disadvantages are their weight, making transportation difficult, and the necessity of having them recharged at intervals. Rheostats must be used with storage batteries as well as with other sources of electricity.

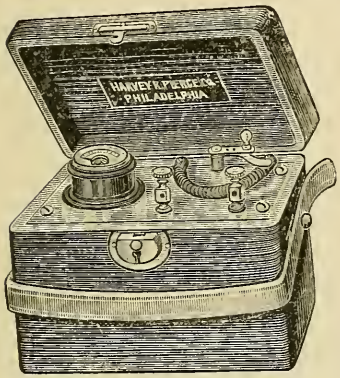


FIG. 24.—Dry cell battery provided with rheostat and ammeter.

For those who must perform cystoscopies in different places a battery composed of from six to twelve dry cells is the most convenient source of supply. Freedom from shocks is assured, and the battery can be easily transported from place to place. The chief disadvantage is the decrease in amperage caused both by the performance of work and the passage of time, necessitating frequent renewal of the batteries, and inconveniently halting examinations on account of failing illumination. Under such circumstances it is sometimes impossible to tell without special apparatus whether the cause of an obscured field is depreciation of the battery or clouding of the fluid in the bladder by pus or blood. For this reason it is of great advantage to have a current indicator in the circuit, as in the battery illustrated (Fig. 24). If the amount of current required to produce proper illumination be noted before the cystoscope is placed in the bladder, decrease in the amount of current flowing through the lamp can be remedied by means of the rheostat without removing the cystoscope from the bladder. Turning on more current without the guidance of such a device is apt to result in damage to the lamp.

PREPARATION OF THE PATIENT

General Preparation.—Before examination all patients should be put on a simple light diet, abundance of water, and for one day before the examination thirty to sixty grains of hexamethylenamine or its equivalent. Unless the bowels are regularly moved, an aperient (cascara, podophyllin, aloin, belladonna, and strychnia) is given the night before, followed by a simple enema some hours before the examination is made. A careful cleansing of the vagina is needful in women.

The hypersensitive are benefited by a suppository of the extracts of opium (gr. i) and belladonna (gr. ¼) given an hour before examination, or still more by a hypodermic injection of morphine sulphate (gr. ⅛ to ¼) and atropine (gr. $^1/_{150}$). These drugs may interfere with the estimation of kidney function.

Local Preparation.—When practicable, exploration of the urethra and prostate should precede by some days the cystoscopic examination. This is desirable, since it accustoms the patient to the passage of urethral instruments. In some cases repeated instrumentation may be indicated for the establishment of tolerance of their introduction.

The immediate local preparation consists in the thorough cleansing of the external genitalia and surrounding region with soap and water and bichloride solution; when ureteral catheterization is to be performed the inner aspect of the thighs should be included in this preparation.

TECHNIQUE OF CYSTOSCOPY

Position of the Patient.—Cystoscopy is most conveniently performed on a table such as that described on page 28. The position obtained (Fig. 25) with such a table, the one which is most comfortable to the patient and produces the least distortion of the parts, permitting introduction of the cystoscope with the

Fig. 25.—Position for cystoscopy.

greatest facility, can also be secured by placing stools at each side of the foot of the table to support the patient's feet.

When it is necessary to do a cystoscopy in a patient's home, the examination can be conducted on an ordinary table, or even with the patient lying across the bed.

Preparatory Arrangements.—The following articles should be in readiness, surgically clean (battery, etc., excepted), and in good working order:

Battery or rheostat and cable.
Cystoscope.
Ureteral catheters.
Syringe, glass or metal, holding 100 to 200 c.c.
Syringe, glass dressing, ½ to 1 oz. capacity.
Two small glass receptacles.
Instillator, with syringe of 1 to 4 drachms capacity, or
Tablet depositor.
Two glass cylinders or beakers.
Six test-tubes.
Meatotome.
Catheters, rubber, Nos. 18 and 20 F.
Catheters, woven, Nos. 18 and 20 F.
Sounds, Nos. 16, 20, 24, and 26 F.
Boric solution, 2 per cent., or physiological saline solution, warm, in percolator (or fountain syringe) equipped with tubing and nozzle which will obturate cystoscope, and in a basin.
Local anæsthetic (5 per cent. eucaine lactate or novocaine).
Cocaine, 10 per cent., 1 drachm (for meatotomy if required).
Lubricant.
Gauze.
Cotton.
Sheets and towels.
Solutions for local preparation.

If functional tests are to be made, the drugs and syringes necessary for the tests selected.

If pyelography is to be done, the silver preparation of choice, and syringe or other apparatus for its injection.

Mode of Procedure.—Cleanse patient's genitalia, and cover thighs and abdomen with sterile sheets.

Irrigate the anterior urethra.

Place local anæsthetic in posterior urethra, or in females within the meatus (women require less perfect anæsthetization than men; frequently no anæsthetic is indicated).

Cleanse lenses of cystoscope, and ascertain the amount of current required to properly supply the lamp; the incandescence of the filament should be such that the loop is not plainly seen when the lamp is glanced at quickly. After the introduction of the cystoscope the current is to be turned on to the point noted; increase beyond this point imperils the filament. Place catheters in their places in the cystoscope, after demonstrating them to be patulous by forcing water through them with a syringe. If indigocarmin, etc., is to be given, see that apparatus for its administration is assembled. (These preparations are made at this time to allow time for the action of the anæsthetizing drug.)

Pass cystoscope into bladder. In doing this the operator should stand between the patient's thighs, draw the penis gently upward and to his right with his left hand, insert the tip of the thoroughly lubricated instrument into the meatus, and, keeping the tip constantly directed along the urethral roof, allow

the cystoscope to slowly pass into the urethra (Fig. 26), largely by its own weight. When the tip of the instrument has reached the bulb the fingers of the left hand should be placed beneath the scrotum (Fig. 27), so as to guide the tip into the membranous urethra, while the ocular end of the instrument is lowered till the cystoscope is parallel with the table and pushed gently upon till the tip is felt to pass over the prostate into the bladder. The obturator is then removed, the urine evacuated, and the bladder irrigated repeatedly through the sheath of the cystoscope by means of a fountain or piston syringe till the return fluid appears perfectly clear when examined by transmitted light. The

FIG. 26. FIG. 27

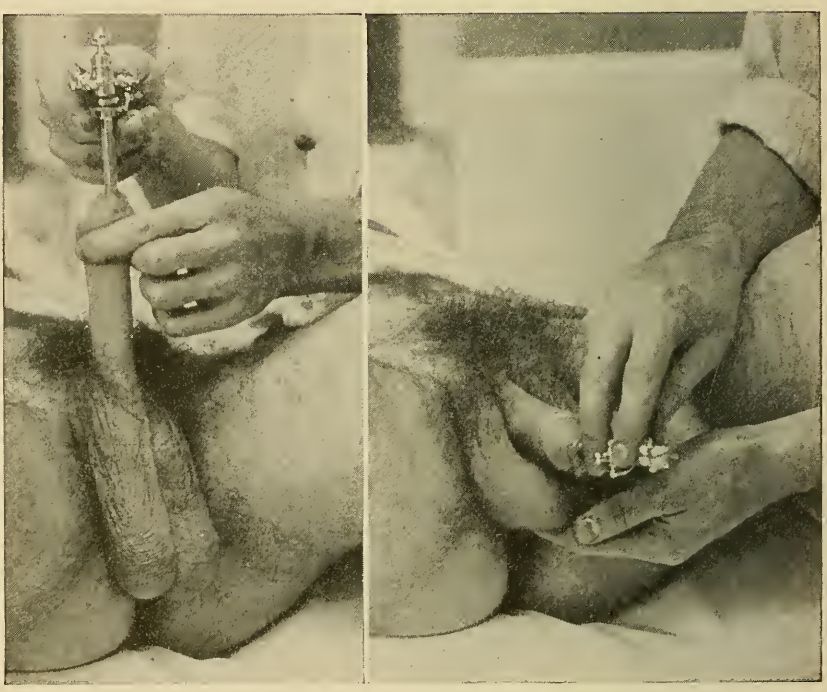


FIG. 26.—Introduction of cystoscope. The penis is drawn upward and the instrument allowed to slip through the anterior urethra by its own weight. The examiner is standing at the patient's side so as not to obstruct the view.

FIG. 27.—Introduction of cystoscope. The fingers of the left hand are guiding the instrument into the membranous urethra.

bladder is then filled with solution (boric or physiological saline, 150 c.c. in men and 200 c.c. in women), or less if these quantities cause discomfort, and the optical system inserted, or, if the cystoscope is furnished with pet cocks for the control of the bladder medium, the telescope may be inserted before filling the bladder. (The foregoing description relates particularly to cystoscopes of the evacuation type. In the case of cystoscopes with fixed optical systems the patient must first be catheterized, the bladder irrigated, and the fluid injected before the introduction of the cystoscope. If the urine be perfectly clear this may be used as the medium for the examination, in which case the cystoscope is introduced without preliminary catheterization.)

The examiner now seats himself on a stool of convenient height, makes the electrical connections, and proceeds with the examination. This is best conducted after a regular routine, the one suggested being anterior wall, right side, apex, left side, posterior wall, and base. The different portions are brought into view by varying the depth of insertion into the bladder, rotating the cystoscope on its longitudinal axis, and by moving the ocular from side to side and up and down so far as the comfort of the patient will permit. Care must be taken not to traumatize the vesical mucosa, and especially not to allow the lamp to remain on any one spot for more than a few seconds, for fear of producing a burn. Before concluding the examination the contour of the urethral orifice should be observed by holding the cystoscope so that the field is bisected by the margin of the orifice, which is thus seen in profile, and rotating the instrument.

The base and vesical neck are the most frequent sites of pathological conditions.

At the conclusion of the examination the electrical connections are broken, the cystoscope is turned so that its beak points upward, the bladder is emptied by the withdrawal of the optical system and the obturator placed in position (if the cystoscope is of the evacuation type), and the instrument is withdrawn, reversing the steps of its introduction.

The whole examination must be conducted with the greatest gentleness. Each movement of the cystoscope should be as small as circumstances will permit, and should be made in a slow, steady, purposeful manner, thereby causing the least possible discomfort and inspiring confidence in the patient. Rapid breathing through the open mouth often seems to relax spasm, and centres the patient's attention on another portion of his body.

A strict aseptic technique should be pursued when doing ureteral catherization; mere cleanliness, with care to avoid touching the intra-urethral portion of any instrument, is sufficient in the performance of simple cystoscopy.

In learning the use of the cystoscope the surgeon must first teach himself to bring closely into view every portion of the inner surface of the bladder. The phantom bladder, cadavera, and sexual neurasthenics, who are often benefited by prolonged and painful manipulation, offer the best opportunities for this training. Finally comes the right interpretation of what is seen, requiring a wide clinical experience. In the hands of one without experience the cystoscope becomes, in most cases, simply a surgical toy. The experienced cystoscopist may be expected to determine the presence or absence of tumors, stones, foreign bodies, diverticula, and ulcerations, the extent and character of a cystitis, the condition of the ureteral orifices, the nature of urinary obstruction at the vesical orifice, the secretory activity of each kidney, and the source of blood or pus in the urine. Furthermore, in conjunction with the Röntgen rays, ureteral catheterization, and the injection of a silver solution, hydronephrosis and enlargements of the renal pelvis can be detected. As a therapeutic agent the cystoscope is used in performing lavage of the renal pelvis, in the dilatation of strictured ureters, in the removal of ureterocystic and small vesical calculi, and in the treatment of vesical growths with the high-frequency current.

NORMAL CYSTOSCOPIC APPEARANCE

The mucosa of the normal bladder is straw-yellow in color, displaying pink tints here and there, with arborescent vessels upon its surface and slight but distinct trabeculæ. Depression of the shaft of the cystoscope and half rotation show the base and the trigonum; at the posterior angles of the trigonum are the ureteral orifices, each appearing as a depression or slit placed in a little ridge of mucous membrane. At intervals of from ten to sixty seconds, or more, not

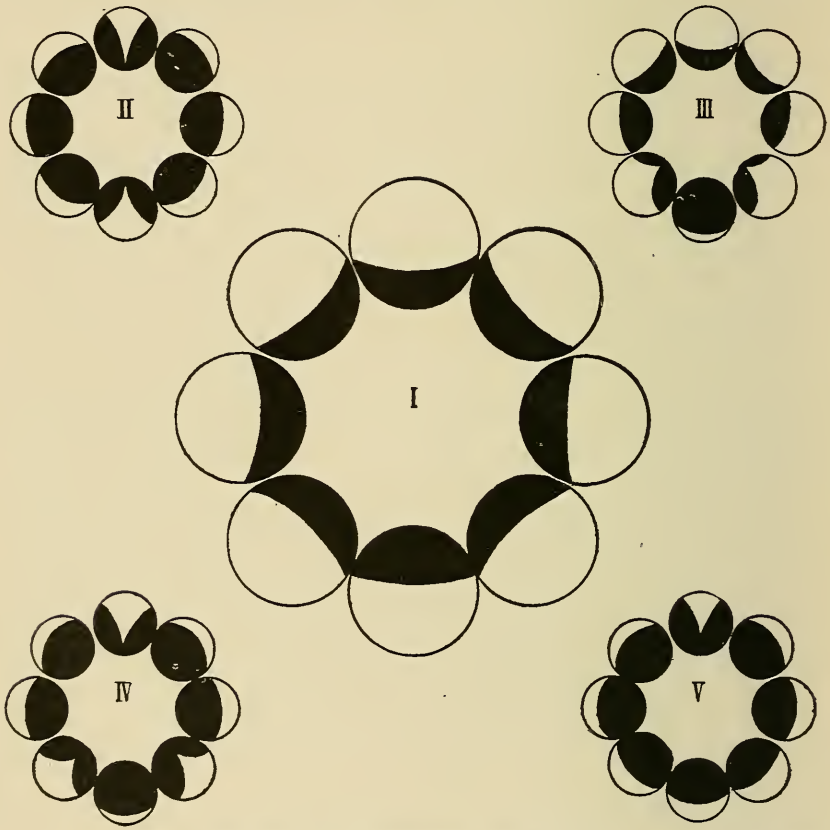


FIG. 28.—Urethral orifice in the male as seen through indirect inverted image cystoscope. I. Prostate normal. II. Bilateral enlargement of prostate. III. Median lobe hypertrophy. IV. Hypertrophy of median and both lateral lobes. V. Same as IV, but with lobes confluent. (After Young.)

synchronously, these ureteral orifices gape and discharge a swirl of urine. Crossing the upper portion of the trigonum and forming its base the interureteric ridge is characterized by a distinct, often abrupt, transition of color from the straw-yellow of the general bladder cavity to the pink or red of the trigonum. This ridge when traced laterally leads to the ureteral orifices. Occasionally, in place of the ridge there is a distinct conical projection marking the ureteral orifice, exhibiting a motion of recession and protrusion. Failure to find the ureters in

the healthy bladder is generally due to incomplete dilatation of this viscus, the openings of these ducts being concealed in the folds of the vesical mucosa, and appearing when these folds have been obliterated by the proper amount of vesical distention. In case air has entered the bladder during the preliminary washing or injection, it forms a round, movable, shining bubble, from the convex surface of which the cystoscopic lamp is reflected.

It is possible to mistake for a tumor the projection of mucous membrane sometimes seen about the ureteral orifice. The position of the projection and the intermittent jets of urine should prevent such an error. The rugæ of collapsed bladders have been mistaken for papillomata; a further injection should make the nature of the projection sufficiently clear.

In the female due allowance must be made for the effects of the encroachment of an anteflexed, anteverted, pregnant, or fibroid uterus, or of pelvic tumors, which may greatly alter the contour of the bladder wall.

Appearance of the Urethral Orifice in the Male

The determination of the conformation of the urethral orifice is of value for the recognition of the different forms of prostatic hypertrophy. The examination is made by withdrawing the cystoscope till the field is bisected by the margin of the orifice, and then rotating the instrument. The normal orifice gives the picture shown in Diagram I of Fig. 28, the light area representing the illuminated bladder, the dark the urethral mucosa. If one or more of the lobes of the prostate become enlarged, protrusions into the bladder are produced, the limits of the swellings being marked by the presence of fissures, into which the mucosa dips. The fissures are most plainly seen when the examination is made with a cystoscope of comparatively small calibre, so that the lens can be carried some distance from the side of the urethra examined. The cystoscopic appearances of the four commonest forms of prostatic hypertrophy are shown in Fig. 28. The deep anterior and posterior fissures caused by enlargement of the lateral lobes are shown in II; in III is shown enlargement of the median lobe; in IV the appearance of enlargement of the median and lateral lobes, when they remain distinct one from the other; while V represents the appearance of bilateral and median enlargement when the three lobes form a confluent mass.

PATHOLOGICAL APPEARANCES

Blood in the bladder is sometimes a source of error. When deposited on the base of a normal bladder it may present the appearance of a severe subacute, chronic, or ulcerative cystitis. Hemorrhage beneath the mucous membrane causes the formation of a yellow or brownish, partly translucent, projecting tumor, not unlike papilloma. The diagnosis will be suggested by a preceding trauma, such as a recent cystoscopy, and the presence of blood-infiltration and discoloration of the surrounding mucous membrane.

In the acutely or chronically inflamed bladder the rugæ may closely simulate papillomata, particularly if the inflammation is localized in one portion of the bladder, as is sometimes the case. Fenwick describes as one of the appearances of certain forms of chronic cystitis a polyhedral or rectangular quilting of the

bladder, with projections between the seams of swollen, almost translucent, mucous membrane, presenting the appearance of a patch of gelatinous polyps. A similar condition at the base may produce small conical projections, or these may be caused by dilated mucous glands or vesicular inflammation. The vesicles formed are round, translucent, and small, from the size of a pin-head to that of a shot, and are especially numerous over the trigonum. The condition is known as bullous œdema (see Plate V, J).

Acute Cystitis.—In *acute cystitis* the mucous membrane is intensely red, swollen, and elevated (puffy). Flakes of fibrin may be seen here and there. Individual larger blood-vessels appear dilated, but the fine reticulum of small vessels may be invisible in the general œdema. The ureteral eminences are difficult to recognize on account of the general swelling. There may in severe cases be membranous exudate.

Chronic Cystitis.—In *chronic cystitis* the inflammation of the vesical mucous membrane may be diffuse or localized. The diffuse will appear as general redness, always more marked about the trigonum and orifices of the ureters. The localized may show patches of intense redness, excoriations, fissures, and linear ulcers. In addition there may be noted in cases of long-standing vesical ulceration areas of contraction, due in part to cicatrices, in part to muscular hypertrophy.

The localized patches of inflammation are observed in about four-fifths of the cases of cystitis (Garceau).

There may rarely be noted small red, shiny granulations, such as are observed on other mucous membranes. The lymphatic nodules may be visible as small, slightly elevated, whitish translucent bodies resembling sago grains located beneath the mucous coat which covers them. The whole surface may present a ribbed appearance from bladder hypertrophy. Various combined lesions are common. Diffuse inflammation, excoriation, ulceration, patches of contraction, and hypertrophy exist together. In all forms of cystitis the severest lesions are located on the posterior wall and trigonum.

In women the trigonum is almost invariably the site of a chronic granular inflammation, quite red but insensitive (cystitis colli feminis).

Cystitis Cystica.—In cystitis cystica, a form of chronic hyperplastic cystitis, the mucous membrane appears studded with small nodules (Plate V, h). These small nodular elevations of the mucosa are due to isolated islands of epithelium lying in the subepithelial connective tissue, having been formed from hyperplastic columns of the overlying epithelium. After separation they undergo cystic degeneration, having at first a clear mucoid and later a colloid content. Circumscribed areas of dense, inflammatory, cellular infiltration are commonly present in the submucosa. The condition must not be confounded with cystitis colli granularis, bullous œdema, or miliary tuberculosis of the bladder. Carcinomatous degeneration is often the terminal condition.

Ulcerative Cystitis.—*Vesical ulceration* may destroy the whole of the mucous membrane in patches, revealing a smooth, glistening, pyogenic membrane, with white lines of scar-tissue or granulation surface. Ulceration is most frequently seen on the posterior wall and within the trigonum at its upper part.

Nontuberculous ulceration presents lesions generally quite uniform in contour,

A

Anterior bladder-wall, with air bubble.

B

Normal ureteral orifice.

C

Trabeculation of the bladder.

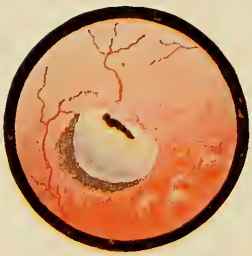
D

Indigocarmin coming from ureter.

E

Double ureteral orifice of bifurcated ureter.

F

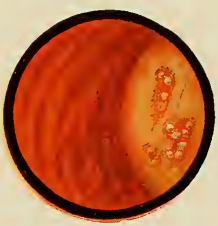


Shell of inspissated pus surmounting ureteral orifice (case of pyonephrosis).

G

Catheter entering normal ureter.

H



Cystitis cystica.

I

Ulcerating gumma (Engelmann).

J

Bullous œdema of vesical trigone (Rumpel).

K

Tuberculous ureteral orifice (case of renal tuberculosis).

L

Vesical calculi.

dirty yellow in color, commonly about the size of a dime, and placed at or near the ureteral orifices. Its edges are slightly raised, undermined, and surrounded by a pale anæmic zone, set in the deeply injected mucous membrane. This must be distinguished from the ulcer. In contrast to the tuberculous lesion, it seldom extends deeply into the underlying tissue, though it may manifest such a tendency. The base is of a yellow or yellowish-white color and usually smooth, though occasionally necrotic shreds may be noted on the surface. The ulcers are usually multiple to the extent of two or three lesions, though they may be single; they occasionally are very numerous, and show a tendency to coalesce, resulting in great destruction of the mucous surface, and presenting a smooth, glistening, pyogenic membrane with intermingled areas of scar-tissue showing as white lines, with red patches where the inflamed mucous surface is still intact.

Traumatic ulcers result from the irritation of large or rough vesical calculi or from the trauma of childbirth.

Rare causes of vesical ulceration are thrombosis, syphilis, and trophic nerve lesions. Thrombotic and syphilitic ulceration are absolutely non-characteristic in cystoscopic appearance.

Vesical Tuberculosis.—In the beginning (*i.e.*, before ulceration has occurred), miliary tubercles appear as grayish, round elevations surrounded by hyperæmic areas. These by coalescence and caseation form the ulcer. This is generally superficial, circular in shape, uneven in contour, dirty yellow in color, and commonly about the size of a dime. Its edges are slightly raised, undermined, and surrounded by a pale anæmic zone, set in the deeply injected mucous membrane.

When sharply outlined ulcers develop, the diagnosis, in the absence of an acute or a chronic cystitis, is not difficult. When there are general infiltration and thickening of the surrounding mucosa, and especially when there is papillary outgrowth, great care should be exercised in forming an opinion as to the tuberculous nature of the lesions from their appearance through the cystoscope.

Some of the most puzzling lesions are the tuberculous granulomata, papillomatous outgrowths usually situated on the base or posterior wall. These granulomata may reach considerable dimensions, even as much as three centimetres in diameter, and with a similar elevation. They may be single or multiple, and have no characteristic form.

The ureteral orifice may be œdematous and pouting, may be eroded, or may have the appearance of a pipe hole. As a rule, the side of the bladder on which the affected kidney lies is the site of the more severe lesions, but the reverse is true in a sufficient percentage of cases to rob the observation of most of its diagnostic value.

Parasitic Ulcers.—Bilharz, many years ago, first directed attention to a parasite, the *Distoma hæmatobia ægyptica,* producing an urological affection endemic in Egypt. The vesical lesions are characterized by thrombotic areas due to the implanted eggs of the parasite, which later undergo ulceration with the production of dark red or brown blood coagula surmounting the small ulcers, imparting an irregular sandy appearance to the mucosa.

Diverticula.—These may be either congenital (Fig. 29) or acquired. The former are recognized by their smooth, rounded orifices in contrast to the rather

irregular openings surrounded by trabeculated bladder wall found in the acquired type. These latter structures are found in patients with urinary obstruction, and are due to a pushing out of the bladder wall between bundles of muscle. Diverticula of either type may be single or multiple, and may be either quite small or of considerable size. Their imperfect drainage tends to the development of diverticulitis.

Cystoscopy is the most satisfactory method of demonstrating the existence and location of vesical diverticula and fistulæ.

Cystoscopic Diagnosis of Vesical Tumors.—Provided that it is possible to manipulate the cystoscope as freely as desired, and that hemorrhage is not too profuse, it is usually possible to determine whether or not a tumor is present; the nature of the tumor cannot be so easily recognized even to the extent of differentiating between the benign and the malignant.

The most important points to be determined in regard to a tumor are its location, size, whether single or multiple, and if possible its nature. All of these points are of great moment in determining upon the mode of treatment, whether this shall be conducted by means of the cystoscope, or whether partial or complete cystectomy shall be performed and by what route (extra, or transperitoneal).

FIG. 29.—Congenital diverticulum of the anterior bladder wall.

Certain tumors, as the myomata and fibromata, unfortunately rare, and appearing as rounded masses covered with normal mucosa, can be readily diagnosed as benign. The tumors of a papillary character—and nearly every kind of vesical tumor may be covered with a villous growth—are less easily disposed of. Often parts of them are benign, as the margins of the growth, while other portions, especially the base, show malignant degeneration on microscopic examination.

A tentative diagnosis of a benign neoplasm may be made when evidence of infiltration of the bladder wall at the base of the tumor is wanting. Judged by this criterion, many malignant tumors, especially papillomata in the early stages of malignant degeneration, will be placed in the benign class, but the results of treatment by the high-frequency current, conducted through the cystoscope, are so much better than those obtained by operative measures in the case of such growths as benign papillomata, and the treatment is so much simpler and less terrifying to the patient, that the mistaken diagnosis is justifiable pending the trial of high-frequency treatment.

Mistakes in the diagnosis of tumor are sometimes caused by the following conditions:

The bulging of extravesical masses into the bladder (as enlargements of the prostate, the uterus, or uterine tumors, etc.), especially when surmounted by bits of blood-clot or flakes of pus.

Enlarged rugæ, the subjects of well-marked inflammation, may be so prominent when the bladder is partially distended as to result in a mistaken diagnosis.

Calculi coated with pus and mucus, especially when partially encysted, are sometimes the causes of mistakes.

URETEROSCOPY

Diseased conditions of the kidneys and ureters are frequently indicated by the appearance of the ureteral orifices. Even in health these structures vary greatly in appearance. Typically they are small slits, placed at the ends of the interureteric ridge; unfortunately the ridge is not a constant structure, as when present it forms a useful guide to the orifices. The relation of the ureteral orifices to that of the urethra, the three lying at the angles of the trigonum, the lines connecting them forming an equilateral triangle, with sides of about two centimetres, also affords a means for their location. When one orifice has been located (with an indirect vision cystoscope) the other can usually be found by rotating the instrument 90 degrees across the base of the bladder. In atypical cases the orifices may be very small or larger than normal; they may also be situated at unequal distances from the urethra. When otherwise invisible they can sometimes be brought into view by pressure from the rectum or vagina. The injection intravenously or intramuscularly of a dye, as indigocarmin, and the observance of its elimination from the ureteral orifices serve both to locate orifices difficult to see and also the relative activity of the functions of the respective kidneys. This procedure is called *chromoureteroscopy*, or chromocystoscopy.

The points to be noted in observing the ureteral orifices are their number (indicative of the number of ureters), their general appearance and that of the surrounding mucosa (whether hyperæmic or pale, large or small, of normal or distorted outline, the presence or absence of œdema, and whether actively contractile or immobile), and the nature of the urinary efflux. Hyperæmia, distortion, and œdema are specially valuable as betokening disease of the corresponding kidney or ureter, as infection, neoplasm, or calculus, especially one low down in the ureter. Ureteral orifices which are immobile and stand open, the so-called "golf-hole" orifices, indicate an atonic condition of the ureter; when inflamed they are said to indicate pyelonephritis. The spurts from diseased kidneys commonly occur at shorter and less regular intervals, and are less voluminous than are those from healthy organs.

URETERAL CATHETERIZATION

The purposes of this procedure are: (1) To determine whether both kidneys exist and their relative function. (2) To secure the urine from each kidney separately, in order to determine the source of such products as pus, blood, epithelium, bacteria, and crystals. (3) To recognize and locate (sometimes in conjunction with the X-rays) such obstructive conditions as torsion and bending of the ureters, valvular folds, calculi, stricture, and ureteral fistulæ, to differentiate between shadows cast by phleboliths and those of ureteral calculi, and to determine the size and shape of the kidney pelvis. (4) To dilate the normal or strictured ureter to facilitate the passage of urine or calculi. (5) To medicate the ureter or kidney pelvis. (6) To drain the kidney.

Ureteral Catheters.—Catheters vary in calibre, in the shape of their tips, and in their surface markings (Fig. 30). The usual size is No. 6 F.; 7 F. is so large that it often traumatizes unnecessarily, while 5 F., except in very small

ureters, permits too great an amount of urine to pass beside it. The generally useful tip for ureteral catheters is the olivary, with at least two openings on the sides; for the collection of urine in determining kidney function the "flute" or "whistle" tip catheters, with openings on the ends and sides, are preferable. The catheters are also supplied either in solid colors or graduated in centimetres by means of alternate bands of different hues, so that the examiner may tell the depth to which the catheter has been inserted into the ureter, thereby aiding him in the location of obstructions. Catheters impregnated with a metal or metallic salts are made for use in skiagraphy.

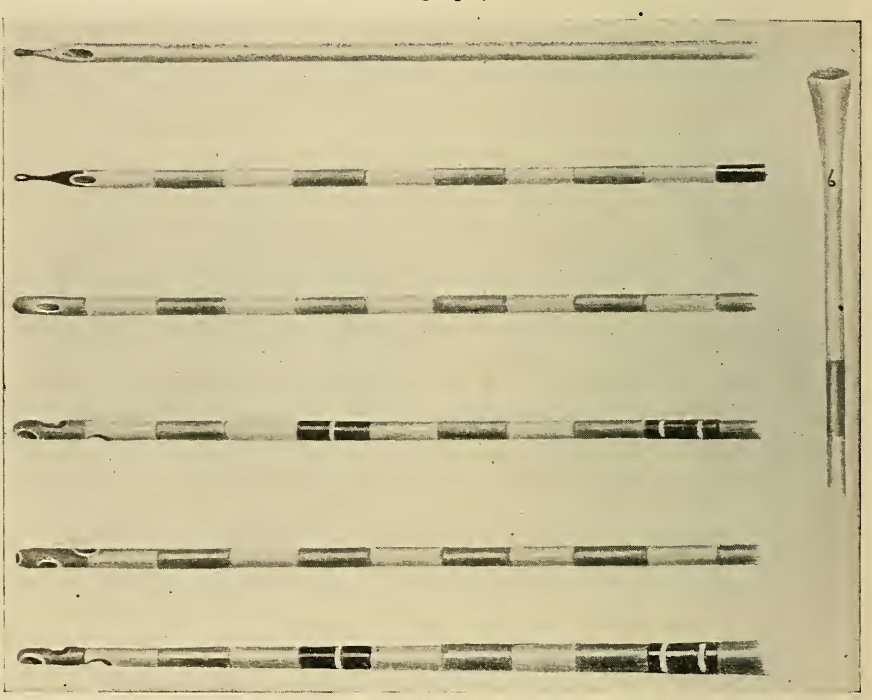


FIG. 30.—Types of ureteral catheters. The one illustrated at the bottom exhibits a long taper, and is intended for dilating the ureteral orifice.

Technique of Ureteral Catheterization.—This is the same as that of simple cystoscopy up to the point of the introduction of the catheters, except that it is desirable to have the catheters in position in the cystoscope before beginning the examination.

Supposing the cystoscope used to be of the indirect vision type, after the bladder has been thoroughly inspected and the orifices have been located, one of them is focused in the centre or to the far side of the centre of the visual field with the cystoscope so placed that the visual rays are as nearly as possible perpendicular to the bladder wall at this point. The catheter in the side of the instrument corresponding to the ureter to be catheterized is then advanced till its tip impinges on the far side of the field, bisecting the field and passing directly across the ureteral opening. If the catheter tends to pass to one side

of the middle it is because it is bent; it should then be twisted between the fingers till it assumes a median position. The deflector is then raised till the tip of the catheter appears to be directly over the mouth of the ureter, when it is again pushed forward, the deflector being either raised or lowered sufficiently to secure entrance into the duct. The deflector is then lowered, the cystoscope turned to the other ureter, and the second catheter inserted in a similar manner.

In direct-vision cystoscopes the catheter is merely advanced toward the orifice, the ocular of the cystoscope being moved up or down or from side to side till the catheter has engaged.

For the collection of urine the catheter is inserted to a depth of ten or fifteen centimetres, being constantly observed the while through the cystoscope to note at once the occurrence of buckling; if it is desired to explore the ureter or medicate the renal pelvis the catheter is advanced till an obstruction is encountered, a distance of from 28 to 35 cm. In the former position the drip from the catheter consists of a series of drops and then a pause; in the latter the drops follow one another at equal intervals. In collecting urine the first cubic centimetre coming from the catheter after it has entered the ureter should be discarded to avoid contamination with fluid from the bladder.

Failure of the urine to flow through the catheters after their introduction into the ureters may be due to plugging of the catheters or to reflex anuria. The catheters having been patent at the time of their introduction, the former is the result of the eye of the catheter lying against a fold of mucous membrane, or being plugged with blood or pus. To secure a flow the catheter should be rotated, advanced slightly or withdrawn a short distance, or a drachm or two of sterile water may be injected to free the lumen. Reflex anuria, due to the presence of the catheter, or even of a cystoscope alone, may be either partial or complete, and may last for half an hour or even longer. The condition must be kept in mind in making a diagnosis of renal inactivity when an instrument has been in the bladder during the examination.

The collection of urine may be done either with the cystoscope still in position, or this instrument may be withdrawn, the catheters being left undisturbed. This is done with the Brown-Buerger type of instrument by removing the rubber caps (cutting off the expanded ends of the catheters, one obliquely and the other straight across, to aid in subsequent identification), turning the cystoscope so that the beak points up if it be not already in that position, lowering the deflector, and then withdrawing first the optical system and then the sheath, being careful that the catheters do not catch on the instruments at any point. The ends of the catheters are then placed in test-tubes or bottles till the desired quantity of urine has accumulated. The greatest care must be exercised to avoid confusing the urine from the two sides.

The catheters should be removed by very gentle traction, to avoid traumatism to the ureters.

RÖNTGENOLOGY

Radiography has a number of important uses in conjunction with cystoscopy, ureteral catheterization, and the injection of such silver preparations as collargol (10 to 15 per cent.), emulsion of the iodide in mucilage of quince seed (5 to 10

per cent.), and argyrol (25 per cent.), or thorium (10 to 15 per cent.), by enabling one to determine the outlines and positions of ureters and kidney pelves. By its aid we are able to recognize and differentiate the various grades of dilatation of the pelvis, hydronephrosis, and hydro-ureter, and in many cases to recognize the obstructive cause of the condition, to differentiate between stones in the ureter and phleboliths and calcified lymph-nodes in its course, to trace the course of aberrant ureters, to recognize anomalies of the kidneys, both of structure and position, and in some cases to differentiate between tumors of the kidneys and other abdominal organs.

The position of the ureters may be determined by passing catheters containing flexible wire stylets, or those impregnated with a metal or metallic salt which is obstructive to the X-rays. If the outline of the ureters or pelves is desired, however, it is necessary to inject them with one of the solutions mentioned before making the skiagram. For this purpose a catheter is introduced to the kidney pelvis and all the contained urine drained off. Either of two techniques may then be followed. The first is to determine the size of the kidney pelvis and ureter by slowly injecting a colored solution, as indigocarmin or methylene blue, watching for the appearance of the dye beside the catheter at the ureteral orifice, and stopping the injecting at this point or when the patient complains of discomfort. The fluid is then allowed to drain off, a slightly smaller quantity of the silver preparation is injected, and the skiagram made immediately. The second plan is to inject only the silver solution, stopping the injection when the patient complains of the least pain, and noting the amount injected as the pelvic capacity. The solutions should be injected by gravity from a burette at an elevation of not more than one foot. A pelvic capacity of 20 c.c. is within the normal limit. The catheter should be withdrawn 10 cm. before making the injection.

The first skiagram should be made of the kidney and upper ureter. If disease or obstruction in the ureter is suspected, a plate should then be made of the lower portion of the ureter, the catheter being partially withdrawn and a little additional solution injected to assure a good shadow in this portion of the tract. If ptosis of the kidney is suspected, a third plate should be made with the patient in the erect posture.

THERAPEUTIC APPLICATIONS OF THE CYSTOSCOPE

Lavage of the Renal Pelves.—Many cases of pyelitis are benefited by the direct application of lotions to the pelvic mucosa. For this purpose a catheter is passed through the ureter till its eye lies within the renal pelvis, as indicated by the regular drop of urine. The solution of choice (any one suitable for irrigation of the bladder may be used) is then injected through the catheter into the pelvis, the exact manner of the injection depending on the nature of the catheter employed. If a No. 5 F. has been used, the lotion may be injected slowly in large quantities by gravity (one foot elevation), the space beside the catheter being depended upon for the escape of the fluid. If a larger catheter has been used, the lotion should be injected in quantities of 10 to 15 c.c., one portion being allowed to drain off through the catheter before the next is introduced. Two-way catheters are made specially for use in pelvic lavage, but the passages are necessarily so small that the catheters are of little value.

Kidney Drainage.—Pathological conditions of the kidney dependent for their origin and perpetuation on urinary back pressure from obstructions in the ureter (*e.g.*, kinks) are greatly benefited by inserting a catheter to the pelvis and allowing it to remain in this position for some time, up to six or eight hours.

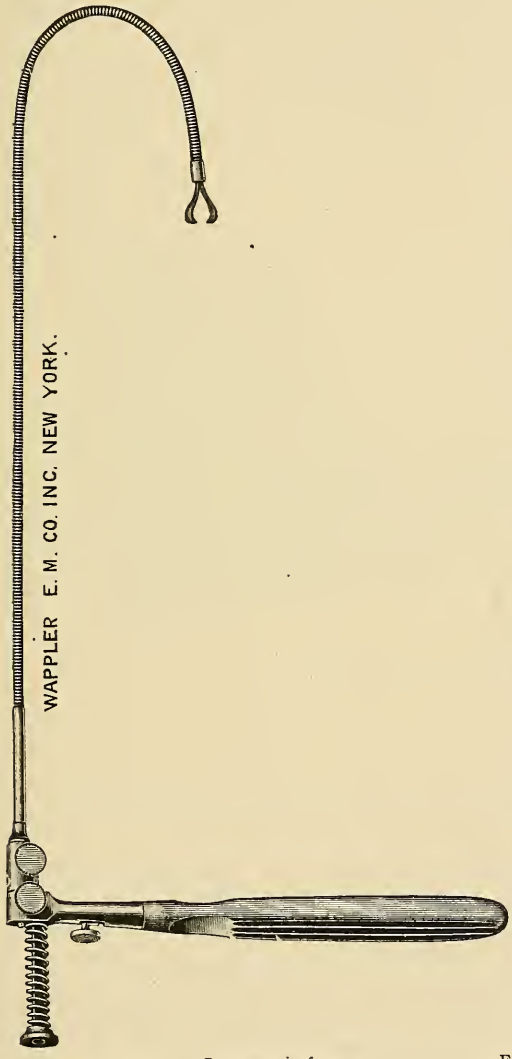


FIG. 31.—Cystoscopic forceps.

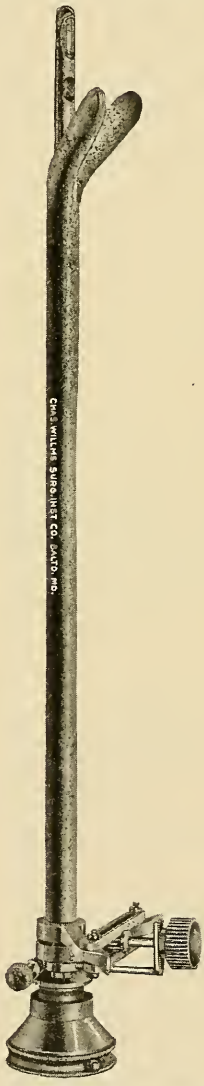


FIG. 32.—Young's cystoscopic rongeur.

Dilatation of the Ureter.—This is used for the correction of strictured conditions, and also in the normal ureter to favor the passage of ureteral calculi. The stretching may be performed by the passage of progressively larger catheters of the olivary tipped variety, or, better, by the use of conical ureteral bougies

for the smaller strictures, and the conical Garceau catheter (Fig. 30), increasing in size from 6 F. at its tip up to 11 F., for the wider dilatations in the lower portion of the ureter. Further enlargement may be secured if necessary by incising the uretheral orifice with scissors or knife through an operating cystoscope for as much as half an inch, or by treating it with the high-frequency current for a few seconds by means of an electrode inserted in the orifice.

As a further aid to the passage of a stone several cubic centimetres of olive oil may be injected in its vicinity by means of a catheter.

Removal of Small Calculi and of Foreign Bodies.—This may be done by grasping forceps (Fig. 31) manipulated through an operating cystoscope, or by means of Young's cystoscopic rongeur (see Fig. 32). The size of the body

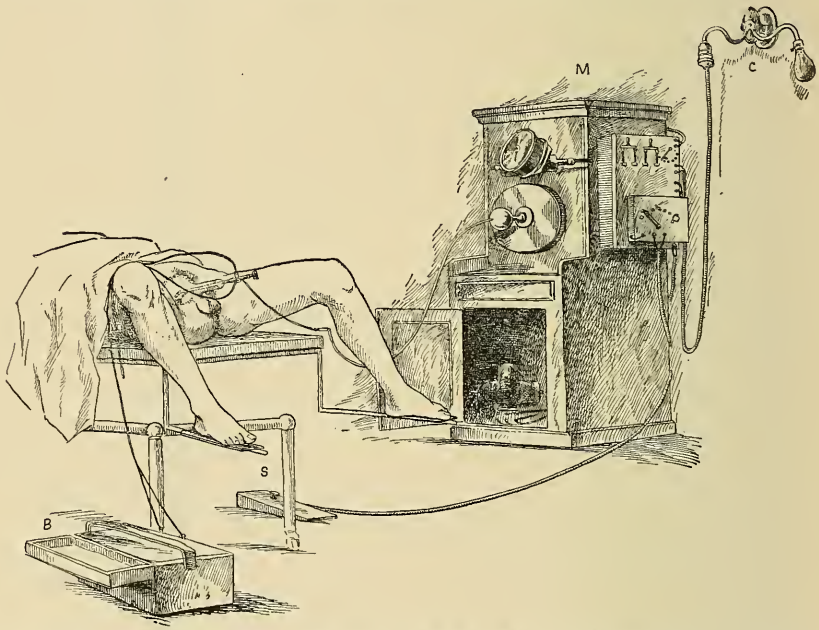


FIG. 33.—High-frequency treatment with large type of coil machine. *M*, high-frequency machine, attached to street current at *C*, and delivering Oudin current to patient. *B*, battery. *S*, foot switch.

that may be so removed varies with the calibre of the urethra and the compressibility of the object. Calculi lodged in the ureteral orifices can sometimes be dislodged by traction with cystoscopic forceps.

Electro-coagulation; "Desiccation" or "Fulguration" with the High-frequency Current.—The destruction of certain bladder tumors, especially the papillomata, by means of the Oudin and D'Arsonval high-frequency currents is now recognized as the best method of treatment of these neoplasms. The patient is not confined as a result of the treatment, a general anæsthetic is not required, the destruction of the tumor is assured, and the percentage of permanent cures is greater than that attained by excision, whether performed by the transurethral (with operating cystoscope) or suprapubic routes; in case of recurrence the patient does not seriously object to repetition of treatment.

The currents may be derived from either a plate or a coil machine; there seems to be no difference in the therapeutic effect. The Oudin current is the one most frequently used (Fig. 33).

While the papillomata present the most favorable field for the use of the currents, small median lobe enlargements of the prostate have been attacked with success, and it has been found possible to fracture some calculi by their application. They are not effective against carcinoma.

The currents are applied by means of specially insulated wires introduced through the catheter channels of a catheterizing cystoscope. The wire should project not more than one-sixteenth of an inch beyond the insulation.

Application is made by pressing the wires into the tumor for a distance of two or three millimetres, allowing the current to flow for ten to forty-five seconds with a spark gap of $^1/_{12}$ to $\frac{1}{6}$ inch. The effect on the tumor is a species of desiccation or oxidation, the portion treated sloughing off in the course of a few days. From four to twelve applications may be made at one séance. The treatments should be administered at intervals of one to three weeks, the number required varying with the size of the tumor and the number of applications made at each sitting. Hemorrhage is usually checked by the treatment, but in some cases the bleeding is increased, even to an alarming degree.

Topical Applications.—The application of medicaments directly to bladder lesions, their curettement, or cauterization are rarely indicated. Occasionally, however, tuberculous ulcers and granulomata and indolent nontuberculous conditions are benefited by such treatment. They are best carried out with the bladder distended with air, the patient being placed in the Trendelenburg position and the treatment conducted through a cystoscope having a simple straight tube, such as that of Braasch.

CHAPTER VI

SUPPRESSION, RETENTION, AND INCONTINENCE OF URINE

SUPPRESSION OF URINE

By suppression of urine is meant the failure of the kidneys to perform their excretory function. It must be distinguished from retention of urine in the lower urinary tract. Such retention may occasion suppression.

The causes of suppression are (1) nonobstructive and (2) obstructive.

Nonobstructive suppression develops in crippled kidneys secondary to trauma—even trifling trauma—especially that of the genito-urinary tract. It may follow severe systemic injury and is an occasional postanæsthetic and post-operative complication. It is partly reflex, partly toxic, as in the case of extensive burns of the skin, and may be brought about by the passive congestion incident to extreme cardiac weakness.

The symptoms of nonobstructive suppression, aside from the failure to pass water or to present the evidences of fluid retained in the bladder or renal pelves, are those of uræmia.

Obstructive suppression is that associated with blocking of the ureters or of the vesical outlet.

The symptoms of obstructive anuria may be veiled by an accompanying retention, but failure of further excretion on relieving the retention, and the later development of uræmic symptoms will sufficiently mark the diagnosis.

Treatment.—After operations on the genito-urinary organs, free diuresis should be secured, and for this purpose the free ingestion of water and enteroclysis of half-normal salt solution are beneficial. In all cases of failure of the urinary secretion, active elimination should be secured by hot packs, vapor baths, in some cases by pilocarpin hypodermically, and by free purgation by calomel and the saline cathartics. In the common form of suppression due to reflex sympathetic causes, hot poultices, cupping, and other counter-irritants are useful, and it is here that high hot injections of salt solution into the colon are doubly indicated. Hypodermic injections of caffein sodiobenzoate (in three grain doses) sometimes seem to have a beneficial effect on the kidneys. If shock be the cause, intravenous injections of adrenalin chloride or pituitrin are indicated.

The various operative procedures which have been beneficial for suppression *per se*, aside from those directed to its cause, are passage of the ureteral catheter, with or without pelvic lavage, simple puncture of the kidney, splitting the capsule, incisions into the capsule, decapsulation, and nephrotomy. These operations (described elsewhere) should not be done until other measures have failed, nor should they be postponed until the patient becomes apparently moribund, though even then they have been successful. Operative measures are indicated if three days of conservative treatment have proven futile, though cases cured after eight days are reported. A local cause, such as a blocking calculus, should be suspected and searched for in the absence of an acute toxæmia or a preceding history of chronic renal degeneration.

RETENTION OF URINE

Retention implies inability to empty the bladder. This may be due to atony or paralysis of the detrusor muscles, to reflex spasmodic action of the sphincters, or to obstruction at the neck of the bladder or in the urethra.

Locomotor ataxia, Pott's disease, general palsies, sclerosis and severe cerebrospinal injuries may, by interference with the vesical centre of the cord, occasion paralytic retention. The muscles may be directly paralyzed by over-distention, by inflammation extending from the mucous coat or from the peritoneal investment, as in peritonitis, or as the result of degeneration consequent upon prolonged exhausting diseases.

Spasmodic retention may follow shock or injury, operations upon the spermatic cord, the rectum, or the testicles, or prolonged voluntary retention. Obstruction at the vesical orifice may be due to tumor, impacted stone, clot, foreign body, or prostatic hypertrophy.

Retention may be of sudden or of gradual onset, and may be partial or complete.

The retention of sudden onset is typified by that observed in cases of rupture of the urethra, or of impacted stone, or of reflex spasm following operations on the anus. The symptoms are pains felt in the region of the bladder and steadily increasing in intensity, recurrent unavailing efforts at micturition with a constant torturing desire, extreme tenderness over the region of the bladder, and the formation of a distinct tumor, dull on percussion, globular in shape, and sometimes extending as high as the umbilicus. Rectal and suprapubic palpation show that this tumor is fluctuating, and that it occupies the position of the distended bladder. The final proof is afforded by catheterization.

Gradual retention may develop so insidiously that it is not suspected until direct examination shows the presence of bladder-distention. Urethral stricture, lesions of the cord, intracystic and extracystic growths or inflammations, enlargement of the prostate, and atrophy of the detrusor muscles are common causes of this form of retention. The early symptom is frequent micturition, the stream passing with little force and often with much diminished volume. This frequency is due to the fact that the bladder is unable to empty itself entirely, a certain amount of residual urine remaining.

Even when the vesical muscles are healthy, if the flow of urine is so obstructed that the time required to empty the bladder is unduly prolonged, the involuntary detrusor muscles, becoming tired, relax before the bladder is thoroughly empty, thus allowing a certain amount of residual urine. This residual urine is proportionate in quantity to the degree of obstruction encountered in the urethra and to the loss of tone of the bladder muscles. When sterile and moderate in amount the only symptom it causes is increased frequency of urination. The reason for this is obvious: if the bladder cannot hold more than ten ounces comfortably, and if, when it is full, an unsuccessful effort is made to empty it, five ounces remaining, the desire to urinate will again occur when five more ounces have been secreted by the kidneys, since the bladder will then contain ten ounces. Its capacity as a receiver of urine from the kidneys is lessened proportionately to the amount of residual urine it contains.

When the retained urine exceeds four to six ounces, because of the frequent urinations and the more or less sustained tension, there develops a certain degree of chronic congestion of the bladder, which is often markedly increased by cystitis and fermentation of the stagnant urine.

As the obstruction gradually increases, and as the muscles become atonic or atrophic from congestion, inflammation, and overstretching, the bladder is more and more dilated, until, finally, it may reach enormous proportions. When this gradual retention occurs in the course of fevers,—typhoid, for instance,—it is probably due to degeneration of the detrusor muscles and to abolition of the normal reflex. The bladder may then slowly distend, giving rise to no symptoms other than apparent incontinence, the sphincter muscle yielding when the intravesical tension becomes sufficiently high and allowing the urine to trickle

FIG. 34.—Tumor formed by the distended bladder. Gradual distention from hypertrophied prostate.

slowly away. The same gradual unsuspected distention develops in chronic prostatic overgrowth, the symptoms suggesting incontinence rather than retention, and the true condition not being suspected till inspection or palpation shows a hypogastric tumor (see Fig. 34).

When associated with fevers, and, indeed, under all circumstances, incontinence of urine should lead to careful examination for an over-distended bladder.

When the bladder is able to empty itself partially, the retention is incomplete. When no urine can be passed, it is complete. In either case there results an abnormal intravesical tension, intermittent when the function of micturition is not entirely suppressed, continuous and steadily increasing in case of complete retention.

THE EFFECTS OF RETENTION.—Guyon and Albarran have shown experimentally that even a moderate amount of retention causes distinct vesical congestion, followed, if the retention is not relieved, by ecchymoses, bloody extra-

vasation, involving the whole thickness of the bladder-walls, and pronounced epithelial desquamation. The ureters and the kidney pelves and tubules show the same changes,—*i.e.,* intense congestion and parenchymatous ecchymoses and epithelial degeneration and shedding. The peritoneum overlying the bladder is often congested and ecchymotic, and the intestines and abdominal viscera participate in the general vascular engorgement.

As a result of over-distention the detrusor muscles of the bladder are paralyzed, remaining absolutely flaccid, even though the urine be drawn. The desquamation of the stratified pavement epithelium, which when normal and unbroken prevents absorption from the bladder, exposes the lymph- and blood-channels, thus favoring systemic infection and toxæmia. Ultimately the sphincter muscle and valve at the vesical orifice of the ureter becomes insufficient, since even inert bodies, such as powdered charcoal, will, if injected into the bladder, ascend in small quantities into the kidney pelves.

Death results from uræmia, very exceptionally from rupture. The temperature in the absence of infection is normal or sub-normal. The extent and severity of the lesions described are dependent on the degree of vesical distention, and this in turn is proportionate to the duration of the complete retention and the quantity of urine secreted.

As a result of experimental research and clinical study, the immediate effects of extreme acute distention of the bladder may be summarized as follows: The bladder, prostate, ureters, and kidneys are enormously congested. The muscles of the bladder become insufficient, and their fasciculi are often mechanically separated by the distention, producing the ribbed or trabeculated bladder. The kidneys, at first excited to increased activity, as pressure increases secrete slowly or not at all. Exceptionally, after relief of tension, anuria develops; more frequently there is pronounced polyuria. The whole urinary tract is ripe for infection, and absorption from this tract takes place readily.

If microörganisms are introduced into the bladder they very rapidly produce cystitis and quickly reach the kidneys. The introduction of similar organisms into the healthy bladder is without evil effect, since the flat epithelium prevents their entrance into the tissues, and the intermittent stream of water from the ureters keep them from ascending along these channels.

Chronic retention produces pathological alterations which are less immediately threatening than those of acute retention. There is chronic congestion of the entire urinary apparatus, with pronounced susceptibility to infection. When the retention is moderate and incomplete these changes are limited solely to the bladder, since the ureters and kidneys are affected only when vesical tension has been long continued or of considerable degree.

If fever develops, it is nearly always due to concomitant infection, and not to retention itself. The temperature is normal or subnormal in both acute and chronic retention.

Although the immediate effects of chronic retention, the use of the term chronic necessarily implying that the retention is incomplete, are less serious than those of acute retention, the ultimate results are equally disastrous; the bladder dilating and losing tonicity, and the ureters, kidney pelves, and kidneys becoming involved.

The bladder muscle may be completely and permanently paralyzed, or, where the retention is partial, particularly in case of stricture, it may be greatly hypertrophied. This hypertrophy is none the less followed by dilatation of the ureters and their pelves and profound alterations in the stricture of the kidneys. (Fig. 35.)

The general treatment of acute and of chronic retention calls for relief of tension as soon as possible, and the observance of rigorous antiseptic precautions in the use of the catheter. Sudden evacuation of the bladder in cases of chronic retention often occasions bleeding not only from the bladder, but also from the

FIG. 35.—Hypertrophied bladder from urethral stricture. Dilatation of ureters and kidney pelves.

kidneys and into the substance of these organs. This is less liable to occur when the urine of acute retention is drawn. It is due to the rapid diminution of pressure to which engorged vessels have long become accustomed. The renal congestion is often evinced by blood-casts.

Exceptionally, after the first evacuation there may be such marked relief of congestion that the power of micturition is restored. Usually catheterization must be employed for some time. Where there is polyuria—and this is frequently the case—it is important to catheterize the bladder frequently. This manipulation may have to be repeated every two hours. The intervals should

be such that not more than eight to twelve ounces shall accumulate before being drawn.

From an etiological standpoint retention of urine may be classified as follows:

1. Retention due to paresis or incoördination of the bladder muscles.
2. Retention from congestion or acute inflammation.
3. Retention due to blocking of the urethra by clots, foreign body, stone, or portions of new-growth.
4. Retention caused by prostatic enlargement.
5. Retention caused by stricture.
6. Retention due to traumatism.

Retention of Urine Due to Incoördination of the Bladder Muscles

Under this heading are classed those cases in which narrowing or pathological alteration of the channel of exit for the urine plays no part. The cause of retention is either failure of detrusor power or loss of control over the sphincters, these not relaxing as they normally should when the detrusors contract. This form of retention is common in cerebral injury, in hemiplegia, in paraplegia, in spinal injury or disease, in Pott's disease, and in spinal ataxias. In ataxic cases the retention may be from sensory failure, the patient not perceiving when the bladder is full; a catheter must then be used not according to a feeling of vesical repletion, but at certain definite times.

The retention sometimes observed in shock, hysteria, peritonitis, paravesical inflammation, exhausting diseases, neurasthenia, and voluntary postponement of the act of micturition may be partly spasmodic, but is probably due in the main to muscular atony and disordered reflex action. Retention following operations about the anus or complicating a full rectum is usually spasmodic, the sphincter being excited to undue irritability not only by the nervous reflex, but also by the vascular engorgement consequent on these operations.

Symptoms.—Retention, whatever be its cause, is characterized by the same symptom, *i.e.*, the formation of a fluctuating tumor in the bladder region. In cases of paraplegia or abolition of sensibility the pain and frequent efforts at urination are wanting. Under other circumstances, if the retention has been of sudden onset, the distress it occasions is characteristic and unmistakable. Since the urethra is patulous, there develops, usually before there is much back pressure exerted in the direction of the kidneys, a dribbling of urine, the incontinence of retention, which is misleading. A patient who complains of incontinence should always be examined for retention.

Diagnosis.—The probable absence of urethral or prostatic obstruction will be founded on the patient's previous history, or, if this is unobtainable, urethral exploration will show that the way to the bladder is unobstructed. Spasm of the compressor urethræ may be misleading, but this yields completely to the gentle, steady pressure of a steel sound or catheter.

When retention develops without apparent cause in a person who gives no previous history of urethral or bladder trouble, the neuropathies must be suspected, and search should be made for corroborative signs of ataxia.

Treatment.—Retention which is a local expression of hysteria or neuras-

thenia is usually relieved promptly by a hot-water enema (103° F.), followed by a hot sitz-bath or general bath. The patient is directed to pass the enema while still in the bath, and usually will urinate without difficulty during the act of defecation. This treatment is efficient in retention from constipation, anal operations, inflammation, shock, or prolonged voluntary retention.

When the hot enema and bath fail, or if these cannot be applied, catheterization is indicated. This must be practised with precisely the same care as would be exercised by the surgeon were he about to perform a major operation, since the bladder is peculiarly vulnerable to sepsis and the kidneys are ripe for an ascending infection.

The evacuating instrument, preferably a soft rubber catheter, about No. 16 F., is lubricated, introduced as far as the membranous urethra, and attached to an irrigating-bag containing a hot dilute antiseptic solution (2 per cent. boric acid; 1 to 2000 protargol; 1 to 5000 silver nitrate, or 1 to 20,000 bichloride). A half-pint of this solution is allowed to flow through the catheter, thoroughly irrigating the anterior urethra; the irrigating-bag is then disconnected, and the catheter is passed into the bladder.

When retention has been chronic and progressive, and particularly when there is also infection, the sudden emptying of the bladder is liable to be followed by severe hemorrhage, which, involving the kidneys and their pelves, may result in partial or complete suppression of urine and thus prove fatal. (For precautions to be taken, see p. 72.)

When retention is due to a central nerve lesion, as in Pott's disease, trauma, or ataxia, or to muscular degeneration, as in typhoid fever or in arteriosclerosis, regular aseptic catheterization must be practised as frequently as is required to prevent abnormal vesical tension. If at any time more than twelve ounces are drawn, this indicates that the intervals between instrumentation are too long. Practised with due attention to cleanliness, these catheterizations prevent cystitis, since they relieve the venous engorgement, which is the most potent predisposing factor to infection.

In all these cases urinary antiseptics should be administered by the mouth, and careful attention should be given to the diet and to general hygiene.

Retention of Urine from Congestion or Acute Inflammation

When, as the result of a severe gonorrhœa, an irritating injection, rough sounding, inflammation of Cowper's gland, or a prostatic abscess, retention develops, this may be due partly to blocking of the urethra by inflammatory swelling, partly to spasm. In the vast majority of cases neither spasm nor acute urethritis is competent to cause complete retention. When this develops there is usually a preëxisting lesion, such as stricture of large calibre, chronic prostatitis with sclerosis and contracture of the internal vesical sphincter, or moderate prostatic enlargement, not sufficiently obstructive in the absence of acute inflammation to cause even partial retention.

Symptoms.—Aside from the characteristic symptoms of retention, the determination of the cause of this condition will depend in the main upon the preceding history. If symptoms of enlarged prostate or of long-standing gleet

are absent, and if in the course of an acute gonorrhœa, for instance, retention develops, the cause of this must be looked for either in the urethra—usually in its membranous part—or in the prostate. Before exploring the urethra the prostate should be palpated per rectum; if this is normal in size and non-sensitive, urethral inflammation and spasm may be suspected as the cause of retention.

Treatment.—The hot bath and hot enema are indicated, since instrumentation should be avoided because of the danger of infecting the bladder. If these measures, reinforced by opium suppositories or morphine injections, prove useless, a woven coudé catheter should be passed, since the urethral spasm is so tight that it effectively resists the softer instrument. This may cause such agonizing pain that it is well to use a local anæsthetic (eucaine or novocaine), or even to administer ether to the first stage each time it is passed. It should be preceded by urethral irrigation, and should be withdrawn while an antiseptic solution is flowing through it.

When the prostate felt through the rectum is large, hot, and tender, recourse may be had to hot baths, enemas, and opium, but there is little hope of relieving vesical tension by these means unless the swelling is purely congestive. In that case it should subside promptly under treatment, and palliative measures should be efficient. Should they fail, the catheter must be used without delay, not only for immediate relief, but also because by regularly emptying the bladder this viscus is less likely to become infected. A prostatic abscess or a suppurative Cowper's gland should be opened as soon as it is detected, preferably through the perineum.

Retention of Urine from Sudden Blocking of the Urethra or the Vesical Neck.

This form of retention may be due to the lodgement of a stone or foreign body in the urethra, to a pedunculated bladder-tumor situated near the neck of the bladder, and acting as a ball-valve, or to blood-clots sufficiently firm to plug the vesical orifice.

Urethral calculi and foreign bodies are considered in another part of this work.

Blood-clots rarely cause retention when the urethra is unobstructed. They are liable to cause intermittent blocking of the urethra, but are ultimately expelled. In cases of prostatic hypertrophy or stricture, clots may cause absolute retention and may seriously interfere with catheterization.

Symptoms.—Retention of urine from vesical clots will give no characteristic symptoms other than those of sudden retention. Bloody urine containing small clots will usually have been passed before the retention develops. There may be a history of previous hemorrhage, or of a sufficient cause, such as traumatism, for extravasation of blood. The catheter enters the bladder readily, and, even though it is almost immediately blocked by a clot, draws some bloody urine; suction by a syringe draws out fragments of clot and allows the urine to flow.

When the retention is due to a pedunculated tumor or a small movable calculus, the symptoms may be precisely the same as those which characterize retention

from clot, since there are likely to be hæmaturia and sudden stoppage of the stream of urine. If, however, the catheter is passed well within the bladder, its eye is not blocked and the urine flows freely.

Diagnosis.—In deciding whether retention is due to blood-clot, small, movable stone, or pedunculated tumor, the history of the case and the course of the symptoms usually lead to a correct opinion. Thus, stone is preceded by renal colic, by frequency of urination, and by pain felt just behind the meatus at the end of the act. When it is displaced from the neck of the bladder by a metal catheter a characteristic grating may be felt. The urine which is drawn contains but little blood.

A pedunculated vesical tumor may cause an obstruction which readily yields to the catheter and which bleeds freely. The nature of the obstruction would be open to suspicion if, in the absence of symptoms of stone, the patient complained of occasional apparently causeless profuse hæmaturia; if on the relief of retention no clots were drawn, the urine flowing freely as soon as the eye of the catheter reached the bladder; and if urination in the dorsal decubitus prevented the stoppage of the stream. Finally, cystoscopic examination should definitely settle the matter.

Treatment.—Retention from blood-clot does not necessarily call for immediate catheterization, since, provided there is no urethral obstruction, as the clot softens and disintegrates it is passed spontaneously; indeed, it is more likely to escape through the natural passage than through a medium-sized catheter. A hot bath and an opium suppository or a morphine injection to relieve the associated spasm of the sphincters, and efforts at urination made with the patient in the dorsal decubitus and with the pelvis elevated, usually result in relief.

Should these measures fail, the patient is placed on his back with the pelvis elevated, and a large woven catheter is passed till its eye is just within the internal vesical sphincter. This decubitus favors gravitation of the clots to the upper posterior portion of the bladder, where they are less likely to block the catheter before the main bulk of the urine has been drawn off.

When the catheter becomes obstructed from lodgement of a clot in its eye, a drachm of dilute antiseptic solution should be injected forcibly. If after several repetitions of this manœuvre it is apparent that the catheter cannot be kept clear long enough to allow the urine to flow in sufficient quantity to relieve tension, an eight-ounce hard rubber syringe, with a piston which fits accurately, should be attached to the end of the catheter and the clots should be sucked out. Should this method fail, a large evacuating litholapaxy-tube should be passed, and through it the blood should be aspirated.

If because of a large prostate the evacuating tube cannot be passed, either perineal or suprapubic cystotomy is indicated in accordance with the cause of the bleeding. In any event the retention must be relieved and the bladder freed of clots, since the presence of blood in the urine markedly favors the development of cystitis. Emptying the bladder is the most efficient means of stopping further bleeding if this is of cystic origin.

Retention due to a pedunculated cystic tumor can be relieved by catheterization, the instrument pushing aside the growth and preventing it from acting as a plug. The same treatment is appropriate to calculus lodged in the vesical neck.

Retention of Urine from Prostatic Enlargement

Of all forms of urinary retention, that due to hypertrophied prostate is the most frequent. This complication of hypertrophy is infinitely more serious than the disease which causes it. It is due to the increased resistance to the escape of urine offered by alterations of the bladder-neck, elongation and deflection of the prostatic urethra, diminution in the calibre of the latter, and vesical atony. The walls of the vesical orifice are thickened, and the opening is raised above the level of the bas-fond, thus leaving a pouch. The overgrowth may involve

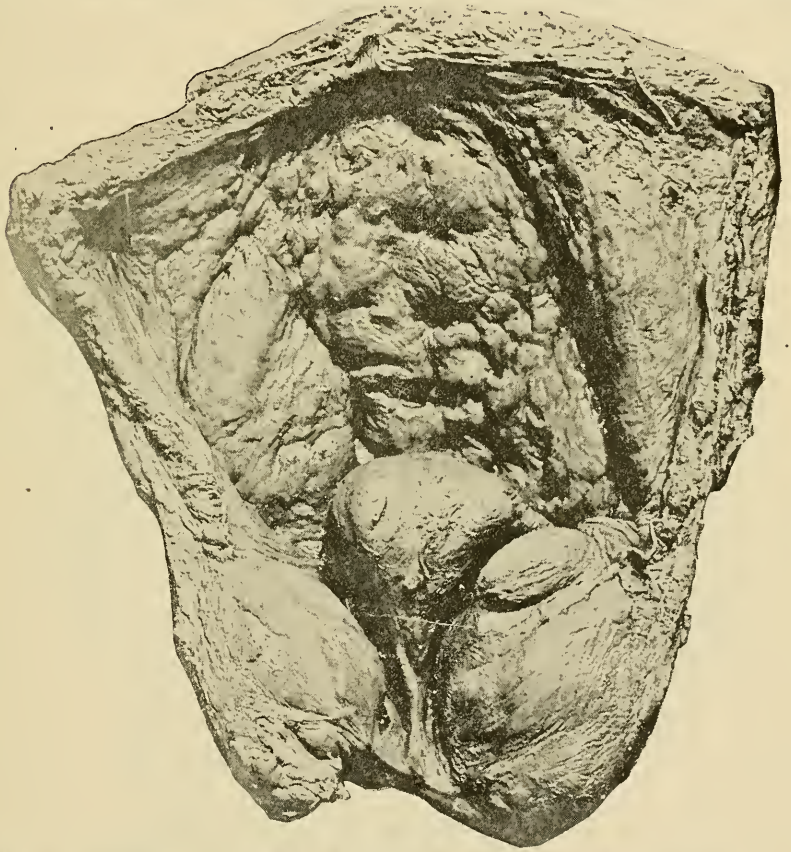


FIG. 36.—Hypertrophy of the lateral and median lobes of the prostate. (Watson.)

one or all of the prostatic lobes; usually the entire prostate is enlarged. (Fig. 36.) From overgrowth of the middle lobe more or less of a projection is formed at the vesical orifice. The enlarged lateral lobes narrow the urethra and force it to one side or the other, in accordance with the position of greatest overgrowth. (Fig. 37.) As a result of this obstruction the bladder muscles become weakened, at least so far as their propulsive power is concerned. There is always very marked hypertrophy of individual fibres or fasciculi, forming prominent ridges. The general symmetrical hypertrophy so frequently observed in partial retention

following stricture is rarely found when obstruction is due to prostatic hypertrophy. Vesical inertia is also encouraged by the muscular degeneration incident to atheroma, which so often complicates enlarged prostate, cystitis, prolonged venous congestion, and over-distention.

FIG. 37.—Hypertrophy of the lateral lobes of the prostate. (Watson.)

As a result of overgrowth the prostatic urethra may be double or even triple its normal length. The vesical orifice and prostatic urethra are encroached upon at the expense of the lower and lateral walls. The superior wall preserves

its normal direction. This fact is important as bearing upon the proper use of catheters for the relief of retention.

The prostate may be tough and fibrous, presenting an obstacle which will yield only to rigid instruments, or may be so friable that it is bruised and lacerated by even soft rubber catheters or exploring bougies. Its dimensions as felt by the rectum do not necessarily indicate the degree of urethral obstruction it occasions.

Symptoms.—During the earliest stages of prostatic enlargement no symptoms are excited upon the part of the bladder; as the growth increases, elevating the internal vesical orifice, there is partial retention, a certain amount of residual urine remaining after each micturition. This, if it is sterile and does not exceed four to six ounces, causes no symptoms other than a slight increase in frequency of urination and a habit of rising once in the early morning hours to empty the bladder.

As the obstruction becomes more pronounced, residual urine increases in amount, the desire to urinate comes more frequently and is more imperative, especially at night; there is usually slowness in starting the stream, and this is projected with less force. Finally, there is distinct vesical atony, the walls of the bladder yield to the slowly increasing tension, and that viscus becomes greatly dilated, sometimes extending above the umbilicus. This dilatation involves the ureter and the kidney pelves. The secreting portion of the kidney becomes insufficient, a condition of uræmia develops, characterized by gastro-intestinal disorders and steady deterioration in health, and death ensues. When the bladder reaches an extreme degree of distention there is a constant dribbling of urine. It should be noted that this train of pathological changes may be evolved without the patient having the faintest conception that there is a condition of vesical tension, the symptoms of which he complains being simply frequent micturition, especially aggravated at night, often attributed to polyuria, and ultimately followed by incontinence of urine, difficulty in starting the stream and loss in its force, and apparently causeless digestive troubles. Should cystitis intervene, the vesical symptoms become so marked that they will scarcely be overlooked. There are then pain, tenesmus, and all the phenomena of bladder-inflammation aggravated by the retention.

If, in the course of chronic incomplete retention, the enlarged prostate becomes suddenly congested from infection, exposure, sexual excesses, indiscretion in diet, or other cause, there will result acute retention, characterized by pain in the bladder and futile efforts at micturition. This acute retention is often not complete, the patient being able to pass a portion of his water, but only after violent straining.

Diagnosis.—Retention due to prostatic enlargement is observed in men past middle age. There is a history of frequent urination, beginning with night rising and slowly becoming more marked. Until an extreme degree of tension is reached, this frequency is always most marked in the night or early morning. Rectal examination or cystoscopy (see p. 47) shows an enlarged prostate, and rectal and suprapubic palpation demonstrate a full bladder. On passing the catheter immediately after voluntary micturition, residual urine is drawn and the urethra is found to be abnormally long. To

measure the urethral length, the catheter is introduced till the water begins to flow; its shaft is then pinched with the thumb at the point corresponding to the meatus. The urethral length is determined by withdrawing the catheter and measuring the distance from the thumb to the eye of the instrument. Normally this should be about seven and a half to eight inches.

Retention from chronic prostatitis accompanied by contraction and sclerosis of the internal vesical sphincter gives the same picture, except that the urethra is not lengthened. Rectal palpation shows a small, hard prostate, and cystoscopic examination fails to demonstrate a nodular median projection at the vesico-urethral junction.

Treatment.—Complete retention from prostatic enlargement always requires prompt mechanical or surgical intervention. The time spent in palliative measures is wasted, and may give an opportunity for the development of irremediable lesions. With very few exceptions, it is possible to pass an instrument into the bladder. The surgeon should be provided with straight

FIG. 38.—Elbowed catheter.

FIG. 39.—Double-elbowed catheter.

FIG. 40.—Silver prostatic catheter.

and elbowed soft rubber catheters, each having a large sunken eye, a solid tip, and a funnel end, flexible woven cylindrical (Fig. 2), and olivary (Fig. 3), woven catheters, single and double elbowed (Figs. 38 and 39), and one or two full-curved silver prostatic catheters (Fig. 40), calibre 16 to 20 F., twelve inches in length, and with an unusually long curve. The calibre of the soft instruments should be from 14 to 18 F. An irrigating apparatus, provided with a conical glass nozzle which can be fitted into the ends of the catheters, a sterile lubricant, and a sufficient number of sterile towels, also must be provided.

If the history of a case suggests the possibility of stricture complicating enlarged prostate, the soft, flexible, bulbous, or olivary bougies will be required. A preliminary rectal examination having been made, the urethra thoroughly flushed out, and the penis and glans cleansed as for an operation, a slit is cut in a sterile towel, and through this the penis is slipped; thus the manipulative area is surrounded by a sterile surface. The surgeon, having sterilized his hands, lubricates a sterilized soft elbowed catheter of medium size, passes it to the compressor urethræ muscle, attaches its free end to the irrigator,

and washes out the anterior urethra. He then anæsthetizes the entire urethra, if this be possible, with a five per cent. solution of eucaine, novocaine, or alypin, applied by means of the instillator (see p. 26). Thereafter he endeavors to pass the elbowed soft catheter into the bladder. When the passage of the catheter is not difficult, catheterization may be accomplished without the surgeon's touching that portion of the catheter which is to be introduced into the urethra, that part of the instrument being handled by means of sterile forceps (Fig. 41) or a sterile towel. When gently repeated efforts, continued for one or two minutes at most, fail, the rubber catheter should be attached to the irrigator, and should be withdrawn while a dilute antiseptic solution (four per cent. boric acid) is flowing through it. A woven catheter (coudé) is then tried. The slight angle at the end of this instrument is of service, partly because it enables it readily to override obstacles, and partly from the fact that the bend keeps the extremity of the instrument applied to the upper urethral wall. It will be remembered that the obstruction is found mainly in the lower and lateral walls of the urethra, the upper portion remaining comparatively normal. Hence, if the end of the instrument is kept constantly in close contact with this normal surface, it can be readily guided into the bladder. The tip of the elbowed catheter must, therefore, be kept against the urethral roof.

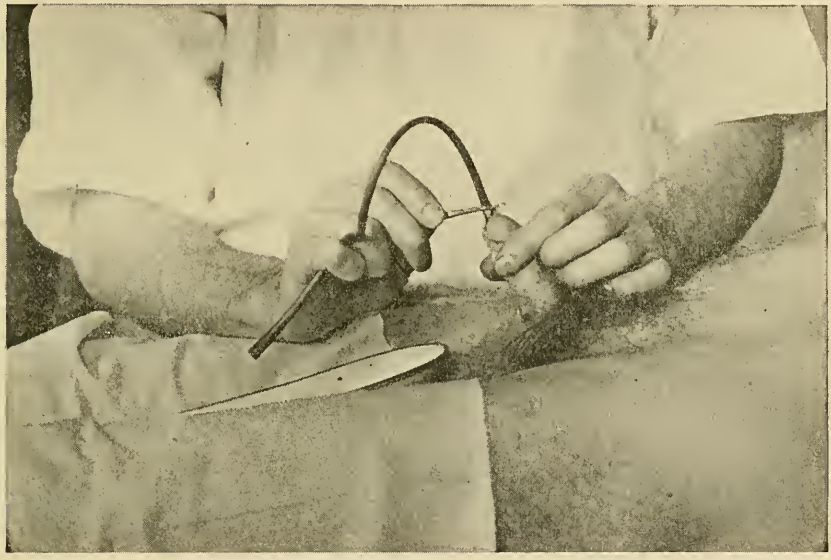


FIG. 41.—Insertion of catheter with aid of forceps.

Should the elbowed catheter fail to gain an entrance, the double elbowed or bi-coudé catheter may be tried.

In the event of this failing, a soft-rubber catheter of small calibre, No. 10 to No. 12 F., is slipped on one of the iron wire stylets with which English catheters are provided. The extremity of this stylet stops one inch short of the eye of the catheter. To the soft-rubber catheter, thus made rigid but

with a perfectly flexible end, a long curve is given by bending the wire. This corresponds in general with that of the prostatic silver catheter. This long curve keeps the tip of the instrument apposed to the urethral roof and thus guides it into the bladder. The rigidity imparted by the stylet enables enough pressure to be applied to overcome any resistance offered by the close apposition of tough fibrous walls, and the flexible end readily finds its way over or around abrupt projections. All these manipulations must be conducted with the utmost gentleness, yet the most skilful manipulation will occasion bleeding because of the intense congestion which always accompanies retention.

Should the soft catheter threaded on the stylet fail to pass, the long prostatic silver catheter may be used. In passing the catheter it must be borne in mind that the urethra is always lengthened, sometimes two or three inches, and that the bladder may not be reached because of failure on the part of the surgeon to pass his instrument far enough. Sometimes a long flexible whalebone guide can be made to pass the obstruction, and a tunnelled catheter can be passed over it, as in cases of stricture, although this procedure is not so uniformly useful in cases of prostatic retention. Should gentle efforts with all these instruments, continued not more than two or three minutes for each, result in failure to reach the bladder, suprapubic aspiration is indicated as a measure of immediate relief.

Suprapubic drainage through a cannula of large size introduced over a trocar under local anæthesia (deep infiltration), as a method of continuous drainage, is attended with more immediate risk than aspiration, but has given satisfactory results where there was no hope of relief by catheterization.

In cases of retention from prostatic enlargement uncomplicated by infection, and particularly when there have been no previous futile attempts at instrumentation, the soft-rubber catheter or the flexible woven elbowed catheter usually enters the bladder without difficulty. When this end is accomplished the surgeon's serious responsibility practically begins. If as a result of long-standing vesical tension there has been dilatation of the ureters or of the kidney pelves, with marked alterations in the kidney structure, and particularly if there has been previous infection, or if this is carried in by instrumentation, sudden evacuation of urine may be followed by suppression, uræmia, and death, occurring in either a few days or a few weeks. When the kidneys are comparatively healthy, sudden complete evacuation of the bladder contents, by interfering with the conditions of pressure to which the blood-vessels have become accustomed, may occasion severe hemorrhage not only in the bladder but in the kidneys themselves. This, even when slight in degree, by favoring the development of cystitis, may constitute a grave complication. If profuse it becomes serious, not only because of its systemic effect, but also because by clotting and obstructing the catheter it interferes with the flow of the urine. To avoid bleeding the urine should be drawn off slowly, with the patient in a recumbent position. Except when the distention is slight and of short duration, the bladder should not be completely emptied at the time of the first catheterization. When the urine is clear and sterile, about half the bladder contents should be allowed to remain. When there is blood or pus in the urine, all of this should be drawn from the bladder, but without allowing

this viscus to be entirely empty at any time. This end is thus attained: Before passing the catheter the bladder is palpated, to enable the surgeon roughly to determine its content. The catheter is introduced and somewhat more than half the retained urine is drawn. This may be two to three pints. Eight to twelve ounces of a warm sterile four per cent. solution of boric acid are then injected into the bladder by means of the irrigator, and immediately the same quantity of mixed boric acid solution and urine is allowed to escape. This partial filling and emptying of the bladder is continued till the blood and pus disappear and the liquid evacuated has the colorless appearance of the boric acid solution. The catheter is then slowly withdrawn, with the boric acid solution still flowing through it.

The rule of treatment in these cases should be regular evacuation of the bladder, the number of catheterizations required daily being regulated by the activity of the kidneys. Four to eight times in twenty-four hours are usually sufficient. Each time enough urine is withdrawn to lessen distinctly the residual amount. This residuum is then replaced by boric acid. In two days the bladder can usually be completely emptied without fear of ill results. Continuance of catheterization is indicated by failure to recover painless, fairly effortless, prompt, voluntary evacuation, but not when the passage of instruments is difficult, or not longer than is needful to prepare the patient for an operation which will radically cure.

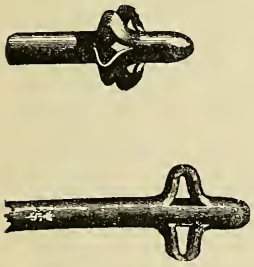


FIG. 42.—Malecot soft rubber self-retaining catheters.

Continuous catheterization is indicated when persistent vesical retention is complicated by a progressive asthenia, gastro-intestinal breakdown, and loss of weight. The indications are still more urgent when symptoms of sepsis develop, and when microscopic and functional tests corroborate the presence of renal infection and markedly depressed function. The permanent catheter does not lessen prostatic enlargement; it simply relieves congestion and spasm by providing for free drainage.

The soft-rubber instruments are best suited to permanent catheterization. If a woven catheter is employed, this should be thin-walled, of as large calibre as possible, and provided with two large terminal eyes. They are placed in the turned-up portion, and hence not likely to be occluded by the bladder walls.

The self-retaining catheter is also useful (Fig. 42). This is of soft rubber, 18 to 22 F., and is provided with lateral terminal projections, which disappear when it is drawn tightly over the metal carrier. It is thus introduced; the carrier is then withdrawn, and the elasticity of the instrument causes the projections to reappear. The surgeon is enabled to determine how far the tip of the instrument is passed into the bladder by gently drawing the catheter out until he feels the resistance caused by these rubber projections when the narrowing of the vesical neck is reached. When this resistance is felt, it is certain that the catheter eye lies just within the grasp of the internal vesical sphincter. If an ordinary catheter is used, the exact depth at which it must be maintained is determined by gently withdrawing it when the contents of

the bladder are almost evacuated and noting the moment when the stream ceases to flow. It is then passed in again until the stream begins to flow, and is fixed at this point.

To determine positively that the instrument is properly placed and completely evacuates the bladder, after the stream has ceased to flow sudden pressure is made in the hypogastric region. If the bladder is empty there will be no jet of urine. Next a definite quantity of antiseptic solution is injected into the bladder; all of it should be returned immediately. Next the end of the catheter should be watched, to see that the urine drops steadily and continuously.

When by these tests the surgeon is assured that the catheter is properly placed, it may be secured in position. The proper placing of the instrument is the most important part of the whole procedure.

FIG. 43.—Retained catheter (straps applied).

The fixation of the catheter is accomplished by fastening threads to strips of rubber adhesive plaster an inch wide applied to the sides of the penis, passing from its root to the level of the meatus, and secured in place by a narrow gauze bandage. The threads should be attached to the catheter close to the meatus (Figs. 43 and 44), and are then passed through holes cut in the free ends of the longitudinal plaster strips.

By means of a piece of sterile glass tubing a clean rubber drainage-tube is attached to the end of the catheter to drain the urine into a urinal containing one or two drachms of liquor formaldehydi and placed at a level lower than that of the bladder. The flow must be continuous.

Twice daily the bladder is irrigated with a mild antiseptic solution (boric acid, ʒi to the pint; protargol, 1 to 4000), the catheter then being slowly withdrawn until the washing solution passing through its eye returns through the meatus. The instrument is then reinserted to the proper depth and secured in that position. A new catheter is substituted as soon as the one

in use shows any surface roughness or incrustation. The time limit varies greatly, the soft-rubber instruments lasting much longer than the woven ones. The full length of the catheter should be inspected every second day.

Continuous catheterization occasions a mechanical urethritis, which is reduced to minimum by the treatment indicated above, and which promptly disappears when the catheter is removed. Ulceration of the urethral floor may be avoided by supporting the penis so that it is prevented from hanging with too pronounced a curve.

Continuous catheterization is usually employed by the surgeon as a temporary means of relieving sepsis and back pressure until the patient's condition is so improved incident to the drainage thus secured that radical treatment can be adopted. Even when most skilfully applied and carefully watched it may cause so much distress as to become impracticable. Perineal or supra-

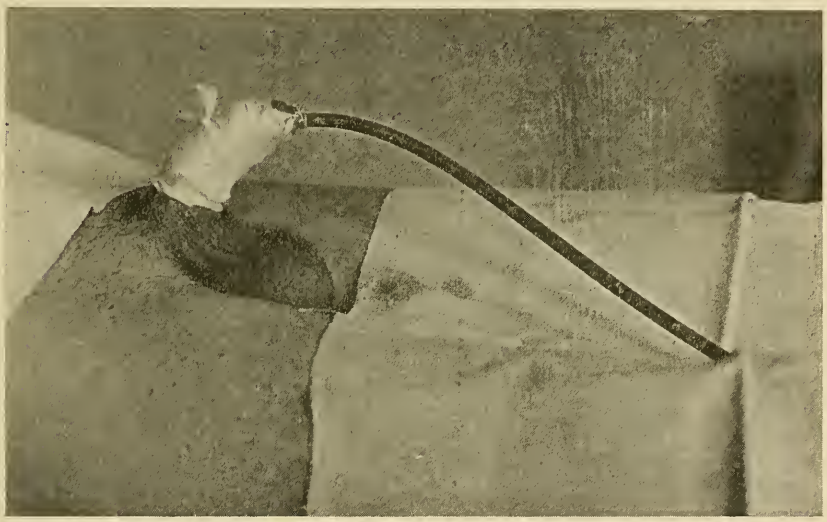


FIG. 44.—Retained catheter. (Dressing completed with bandage.)

pubic drainage is then indicated. Yet in some cases an indwelling catheter may be worn for months or years, draining into a urinal worn beneath the clothing, or being provided with a clamp, so that the patient is able to empty his bladder intermittently into an ordinary urinal. The long-continued instrumentation produces an ultimate tolerance and fibrosis characterized by the almost complete absence of inflammatory reaction.

Aspiration.—When acute retention from any cause is not amenable to catheterization, aspiration is the emergency treatment of choice. It can be performed repeatedly without causing complications.

The bladder is outlined by percussion and palpation, and the suprapubic region is cleansed as for a surgical operation. With a sterile, sharp-pointed tenotome a puncture is made through the skin of the middle line immediately above the symphysis pubis, and the sterile aspirating needle is thrust backward and a little downward through this incision into the bladder. The

lessened resistance will determine when it has penetrated through all the walls of this viscus (see Fig. 45).

The bladder is partially or completely emptied in accordance with the duration of retention and the amount of vesical distention. The aspirating needle is then withdrawn, while suction is still maintained, thus preventing infection of the needle-track with the urine.

These aspirations may be repeated three or four times a day for one or two weeks without infecting the bladder, and usually without causing suppuration of the prevesical cellular tissues. A few cases of extra-vesical abscess

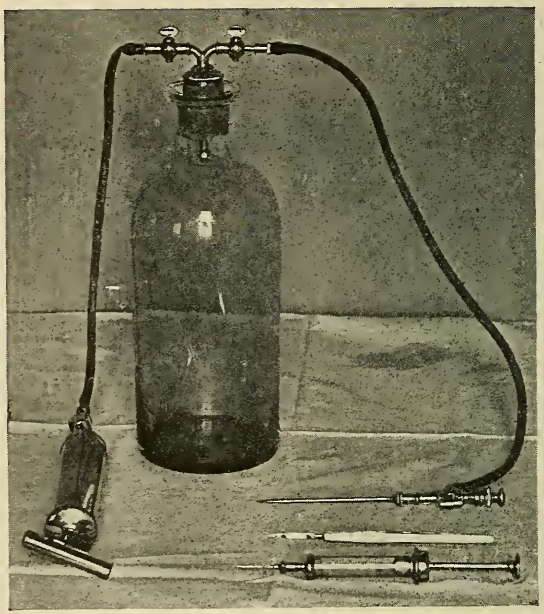


FIG. 45.—Apparatus for aspiration of bladder. Consisting of a hypodermic syringe, filled with 1 per cent. eucain or some similar solution, narrow bistoury for puncturing skin before introduction of aspirating needle, and small trocar and cannula attached by means of tubing to a bottle in which a negative pressure can be established by means of the pump at the left of the picture.

have been reported, when there has been pronounced cystitis. In prostatic retention incident to congestion and spasm, and in the absence of infection, such aspiration may be followed by a symptomatic cure.

INCOMPLETE RETENTION.—The damage inflicted by incomplete retention upon the bladder, ureters, and kidneys is commonly more pronounced and more permanent in its effects than that incident to complete retention, since in the latter case the symptoms are so urgent that relief is obtained by catheterization, and where needful a radical operation is performed, whilst in the former, the symptoms being annoying rather than painful, there is a progressive, often rapid, dilatation of the bladder followed by all the evil effects of back pressure (see p. 62).

Patients suffering from incomplete retention due to prostatic enlargement may complain of no symptoms other than undue frequency, slowness in starting the stream, and lack of propulsive force. Acute prostatic congestion aggravates these symptoms and supplements them by pain and tenesmus. In the early stages of incomplete chronic retention, before the bladder is markedly dilated, as determined by rectal and suprapubic palpation and measurement of the residual urine, the treatment of these occasional exacerbations calls for active purgation, hot normal saline enemata, hot sitz-baths, diluents by the mouth, a bland diet, and rest in bed. In the absence of vesical infection, the catheter should be omitted unless there is overdistention, when instrumental relief is imperatively called for.

Treatment of Chronic Incomplete Retention.—After the surgeon has relieved the acute retention of prostatics, has checked bleeding, and has cured or alleviated the cystitis from which these patients usually suffer, directions must be given which will prevent a return of complete retention and which will keep the bladder in the best condition to resist microbic invasion and preserve it from the effects of abnormal tension. This necessarily implies the operative removal of obstruction, or, as a temporary measure and one fraught with far greater risks in so far as the return of health or continuance of life are concerned, the habitual use of a catheter. The catheter does not cause vesical atony and cystitis, but protects against these sequelæ of prostatic enlargement; its use does not abolish the power of urination, but may restore it; and it is infinitely better to draw the water through an instrument than to pass it at the expense of prolonged and violent straining efforts.

The mechanical part of catheterization is learned by patients quickly enough. The instrument which in each case enters the bladder most readily and gives least pain is the best. This may be a soft-rubber catheter, an elbowed or double-elbowed catheter, the stiff English instrument, or exceptionally even the silver prostatic catheter.

The number of times the catheter is to be passed during the twenty-four hours is dependent on the renal activity, and the relief afforded to the frequently recurring and strongly persistent desire to urinate. In cases of moderate obstruction, disturbing only at night, the passage of an instrument before retiring is sufficient. In more pronounced cases, with polyuria and both nocturnal and diurnal frequency, catheterization may be needful several times a day. When there is pronounced cystitis, pain little if at all relieved by the catheter, and the symptoms of renal insufficiency, intermittent catheterization is worse than a waste of time.

Directions should be given patients concerning the care of instruments and a cleanly method of using them. They must be taught the importance of using sterile catheters in accordance with modern surgical principles. This is especially necessary when cystitis has not developed. The various ingenious contrivances in which patients carry their instruments—for instance, flat boxes and hollow canes—are not to be commended, since it is almost impossible to keep catheters clean when they are thus stored. Catheterization is troublesome at best, and thoroughness in carrying out antiseptic details should not be sacrificed to convenience.

The most comfortable catheter having been selected, the patient should procure twice as many of these as are required in a single day, a fresh instrument being used for each catheterization. Those of American make are quite as good as the imported ones. In addition to the catheters the patient must secure a metal box arranged for their sterilization by paraform, tubes of antiseptic lubricant, a bottle of tablets of mercuric chloride for making a solution of 1 to 1000 in which the hands can be washed, a roll of bichloride gauze, and an irrigating-bag. He should have prepared a dozen clean towels which have been boiled and sun-dried or baked. The catheters are washed in green soap and hot boiled water, washed again in hot water, dried with a clean towel, and wrapped each in a piece of bichloride gauze cut to an appropriate size. They are finally stored in the metal paraform-box for twenty-four hours (Fig. 46).

As each catheter is required for use it is taken from the box, and, with its gauze wrapping still unfolded, is placed on a clean towel. The patient then fills his irrigating-bag with a solution of 1 to 2000 protargol, removes the cap from the lubricant jar, scrubs his hands thoroughly with soap and hot water, washes them in bichloride solution—1 to 1000—scrubs the glans penis with a pledget of cotton dipped in this same solution, again washes his hands in

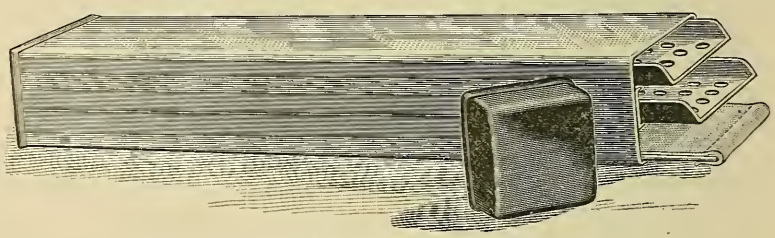


FIG. 46.—Box for sterilizing catheters with formaldehyde.

the bichloride solution, unwraps the catheter, dips it for a moment in a pitcher of hot, recently boiled water, hot boric acid solution, or 1 to 20,000 corrosive chloride solution, to remove the paraform vapor, lubricates it carefully, places a clean towel around the penis, and introduces the instrument, attaching the irrigating apparatus after it has been passed in four inches and allowing the antiseptic solution to flow while the catheter is slowly pushed on into the bladder. After the bladder is emptied, the irrigator is again attached to the catheter during its withdrawal. The catheter thus used is immediately washed and syringed out with hot soapsuds, is dipped for a moment in boiling water, is then shaken to dry out its interior as thoroughly as possible, is wiped dry, and is wrapped in a clean towel. At night the hands are cleansed, and the catheters which have been used during the day are again wrapped in bichloride gauze and put in the paraform-box. This box should be provided with two shelves, each containing enough catheters for twenty-four hours' use.

There are many simpler methods of practising cleanliness in catheterization. The method given above is efficient.

When it cannot be carried out, the catheters should be boiled and wrapped in sterile towels. The hands and the glans penis should be washed with bichloride and the urethra should be cleansed by antiseptic injections practised

with an ordinary urethral syringe before each passage of the instrument. As the latter is withdrawn, the urethra should again be flushed with the antiseptic.

When about to travel, enough catheters should be sterilized to last at least two days. These, with the catheter case, lubricant, antiseptic towels, gauze, absorbent cotton, a small basin for hand solution, and a narrow pint jar for rinsing the formalized catheter may be packed in a small valise.

When the above technique is rigidly enforced, the severe grades of traumatic urethritis incident to repeated and frequent unclean catheterization may be avoided. When cystitis is present irrigations are extremely valuable. A fountain syringe is used, and in general a solution is employed which does not excite inflammatory reaction.

A patient suffering from enlarged prostate should also be given careful instructions in regard to the prophylaxis of the congestive attacks which so frequently cause acute retention.

The diet must be so regulated that the urine shall be unirritating. This necessarily implies treatment for oxaluria, excess of uric acid, or other abnormal condition. Diluents should be given with the same end in view, but not to the extent of markedly increasing the polyuria which is usually present. The surface circulation should be stimulated by bathing, friction, and massage. Open-air exercise is desirable for its effect upon the general health. Even horseback riding or the use of a bicycle is sometimes followed by beneficial results. Tonics, stimulants, and nutrients all have their value.

As a means of avoiding local congestions, the patient must be particularly cautioned against constipation, chilling of the surface, wet feet, resisting the desire to urinate, sexual excess, indulgence in alcohol, or overeating. The treatment directed to lessening the hypertrophy is discussed under a separate heading.

Retention of Urine from Stricture

The retention of urine from stricture must be distinguished from that dependent upon enlarged prostate, since the treatment of the two affections is widely different. In both cases there is usually a preceding history of frequent urination with slowness in starting the stream. Prostatics, however, have most difficulty at night and in the early morning. During the day the water flows with comparative freedom and without much delay. Examination per rectum will usually show enlargement of the prostate. In cases of stricture the frequency is most pronounced in the day, the delay in starting the stream is less marked, and there is liable to be more dribbling. Until retention is well advanced there is distinct remission of symptoms at night. A history of previous gleet or of injury to the perineal or the penile urethra is usually given. It must be recognized that sudden retention may develop in cases of stricture of large calibre without a preceding history of frequency.

The diagnosis is generally founded upon exploration of the urethra with acorn-bougies and digital examination through the rectum.

There is probably incomplete retention in the majority of tight strictures, but of a degree insufficient to produce dangerous vesical tension. Any cause of congestion and urethral spasm, particularly sexual indulgence, excess in

drink, chilling of the surface, or the passage of a catheter, may make the retention complete. This form of complete retention is, however, of short duration.

Treatment.—Since the bladder has a tendency to become hypertrophied rather than dilated, it is rare in the case of stricture to find it enormously distended. Even when the tension is still moderate, the suffering is so intolerable that the help of the surgeon is demanded. Since spasm and congestion play the major *rôle,* a hot bath, hot enemata, opium and belladonna suppositories, and hot turpentine stupes over the hypogastrium may be tried. If these measures fail, the surgeon should promptly proceed to instrumentation. On the chance of the stricture being of large calibre and of the retention being caused mainly by muscular spasm, an effort may be made to introduce a steel sound, 16 to 20 F., into the bladder. If this fails, fine conical and rat-tailed soft catheters should next be tried. These failing, filiform whalebone bougies should be used, and gently manipulated till one enters the bladder. When the filiform has entered the distended bladder, it may be tied in place, with the full assurance that enough urine will leak out beside it to relieve tension, and that the stricture will be sufficiently softened to allow of the passage of larger instruments; or a Gouley's catheter may at once be passed over the filiform as a guide. When a woven filiform bougie can be passed the most useful type of catheter is that of Phillips, which is threaded at the tip to screw into the base of the filiform. In use the filiform is pushed ahead of the catheter, and coils up in the bladder (Fig. 4).

When a filiform cannot be passed, aspiration, by relieving tension and congestion and relaxing spasm, will at times be followed by success on subsequent efforts to pass instruments through the urethra. Usually on failure to pass any instrument external urethrotomy is required.

Retention of Urine from Traumatism

Under this heading is included that form of retention which follows direct injury of the urethra or the bladder. Retention following general trauma, such as that observed in the aged after luxation of the hip or fracture of the thigh, is probably due to disordered reflexes (inhibition of the detrusors or spasm of the sphincters), and is elsewhere described.

Rupture of the bladder may cause retention, partly because the urine escapes through the rent, partly from muscular palsy. Laceration or rupture of the urethra always causes retention. The symptoms and treatment of these injuries will be considered under separate headings. The general indications are immediate closure of the rupture and drainage of the bladder by continuous catheterization or by the perineal drainage-tube.

INCONTINENCE OF URINE

Incontinence of urine results from inability of the sphincters to prevent the escape of urine from the bladder, and is characterized by the involuntary, sometimes the unconscious, escape of urine. Guyon distinguishes as true incontinence that in which the urine escapes without previous urgency or even desire, thus excluding, for instance, those cases of prostatocystitis in which

the desire is so imperious and irresistible that the patient cannot withstand it. He thus tabulates true incontinence:

- Incontinence.
  - Without material lesions of the urinary tract.
    - Incontinence from nerve-lesions.
    - Incontinence from nervous affections.
    - Incontinence of children.
  - With material lesions of the urinary tract.
    - Without retention of urine
      - Mechanical incontinence.
      - Incontinence of tuberculosis.
      - Traumatic incontinence.
      - Incontinence from urethral insufficiency.
    - With retention of urine.
      - Incontinence of stricture.
      - Incontinence of enlarged prostate.

Incontinence Without Lesions of the Urinary Tract

Incontinence due to nerve lesion is usually preceded by retention, the urine escaping drop by drop from the overfull bladder. The conditions, such as the palsies and degenerations, which occasion this retention have been already mentioned. The appropriate treatment is regular aseptic evacuation of the bladder.

Incontinence of nervous affections often appears in the form of an unconscious escape of urine from the bladder, which is never overdistended. Hysteria, neurasthenia, incipient diabetes, and epilepsy occasion this form of incontinence.

Epileptic incontinence is of special interest, since it may be the only symptom to excite suspicion of the nervous affection. Trousseau states that adults who, without lesion of the urethra or bladder, wet their beds at night should be suspected of epilepsy. In these cases suspicion as to epilepsy having been excited, will lead to the detection of other symptoms, which may justify a positive diagnosis. In hysteria and neurasthenia the condition is rare. Any violent emotion, particularly fright, may occasion this form of incontinence.

Incontinence of children is essentially a functional disease. It usually begins about the fourth or fifth year, but sometimes is continued from early infancy. There is a natural tendency towards cure at the period of puberty, but many cases persist beyond this time. It is almost invariably nocturnal. Exceptionally it is both nocturnal and diurnal. The cause of this incontinence is unknown. Heredity is a distinctly predisposing factor. The possibility of epilepsy as an etiological factor should always be carefully considered.

Trousseau classifies this affection as a neurosis, characterized by excessive irritability and exaggerated tonicity of the vesical muscles. Perhaps the most satisfactory explanation is that which attributes this perversion of function to an increased irritability of the prostatic urethra. In cases of posterior urethritis, because of the increased sensibility of the prostatic urethra, the moment the internal vesical sphincter yields and allows the urine to reach this inflamed mucous membrane, the desire to urinate is urgent, imperative, and often irresistible. In the case of a child with a hyperæsthetic posterior urethra, and with spinal reflexes much more readily excited than in adults, particularly during sleep, the escape of the first few drops of urine into the prostatic urethra is probably sufficient to set in active operation the nervous and muscular mechanism of micturition. During the day cerebral control is usually able

to inhibit this reflex, but when the prostatic urethra is particularly irritable the reflex is excited so suddenly that urination takes place before the child has time to control it by a conscious effort.

Diagnosis.—Before deciding that a child who wets his bed at night or soils his clothing in the daytime is suffering from a purely functional trouble, diabetes, polyuria, vesical tuberculosis, cystitis, nephritis, calculus, and foreign body must be eliminated. If the urine is perfectly normal, and is not excessive in quantity, and if urination is painless and is normally accomplished, these various causes of incontinence can be eliminated. Epilepsy must be excluded by having the child watched through several nights.

Treatment.—Since incontinence in children is often due to an exaggerated reflex, a careful search must be made for any abnormality which may indirectly lead to such increased reflex excitability. Thus, the anus and the rectum should be examined for polyp, eczema, fissure, or seat-worms. The urethra should be explored for narrowings or valvular formations, and, since most children are phimotic, it is well on general principles to practise circumcision. This in itself is often curative. Errors of diet must be carefully corrected, and the urine rendered bland by giving water and milk in abundance. Liquids should not, however, be given in the evening. The total quantity of urine passed in twenty-four hours should be measured. This may show that the incontinence is really due to over-distention, the patient secreting during the night more urine than the bladder can retain.

The general system should be strengthened by exercise in the open air, regular bathing, massage in the case of very weak children, and the administration of tonics. Compound syrup of hypophosphites in doses suited to the age is particularly serviceable. It is well to encourage the child in the habit of defecating immediately before bedtime. This end may be accomplished by the regular use of enemata. If the examination of the urine shows oxalates or other sediments in excess, the appropriate dietetic regulations should be enforced.

It sometimes happens that a habit of nocturnal incontinence is due originally to carelessness. The child, though awakened by the desire to urinate, prefers wetting his bed to getting up. Shortly he is so imperfectly awakened that, though micturition is partially volitional, he is practically unconscious of the act. It will be found that the urine is passed at about the same hour every night. If the nurse is directed to inspect the child hourly for two or three nights, the time of semiconscious urination may be determined.

In these cases a cure may be accomplished by having the child waked at about one or two in the morning, or an hour before his habitual time of involuntary micturition, and made to empty his bladder.

As further means of lessening the tendency to nocturnal enuresis, the application of a bandage about the waist of the child, with a projection in the back so that he is compelled to lie on his side, sleeping on a comparatively hard bed with covering just sufficient for necessary warmth, the elevation of the foot of the bed, and counter-irritation in the form of blisters over the lumbar spine, have been tried with apparently satisfactory results.

Medical Treatment.—The drugs administered for the cure of enuresis in children are belladonna, atropine, hyoscine or hyoscyamine, potassium bromide, quinine, and thyroid extract.

Belladonna, the drug upon which reliance has been chiefly placed, is administered in ascending doses until either the physiological effect is obtained or the incontinence is cured. This drug is pushed to the limit of safety; thus, a child four years old may be given an eighth of a grain of belladonna extract, four drops of the tincture, or one to two minims of the fluid extract of the root in the evening. Or the drug may be given in the form of suppository, the dose then being slightly larger. Good results are often secured by administering atropine in increasing doses up to the limit of tolerance. A solution of atropine, one grain in two ounces of water, may be prescribed, so that one drop contains approximately one-thousandth part of a grain. Two to three drops three times a day should be given, the dose being increased by one drop every day or two till the enuresis is controlled or toxic symptoms develop. Hyoscine or hyoscyamine may be employed in doses of the two-hundred-and-fiftieth of a grain; potassium bromide, five to fifteen grains; quinine, two to ten grains. Thyroid extract, in doses of one-fourth to one grain three times a day, sometimes produces a prompt cure of the condition.

If the desired result is not quickly accomplished, no benefit is obtained by continuing these remedies. Should the enuresis be apparently cured, the dose should be gradually lessened. If there is temporary relief followed by relapse, the dose may be cautiously increased. Quinine has been particularly commended by Potts, on the theory that enuresis is probably caused in the greater number of cases by failure of the higher centres to control properly the reflex act by which the bladder is emptied. Quinine was given in full doses as a stimulant to the inhibitory centre, with strikingly satisfactory results in the few cases in which it was tried.

Mechanical Treatment.—This may be applied in the form of (1) sounds, (2) electricity, (3) instillations, (4) epidural or presacral injections. Its object is to relieve the hyperæsthesia and congestion of the prostatic urethra and to stimulate the sphincter muscle.

The passage of a cold steel sound of such size that it enters the bladder without the employment of force is usually efficacious. This sound should be left in place for from three to five minutes, and should be passed every third or fourth day.

If after three weeks of sounding and a fourth week of rest symptoms are not improved, electricity should be employed. This is applied by means of a urethral electrode (Fig. 47) vulcanized to within an inch of its extremity, shaped like a sound, and with the rather sharp curve appropriate to the urethra of children. The electrode is passed into the urethra until its metal extremity lies within the membranous and prostatic portions of this canal. It is then attached to the faradic battery, the other electrode of which is applied over the perineum or to the lumbar spine. The patient is given fifty slow interruptions, the current being so regulated that it does not cause pain. The treatment is repeated every three or four days. The rectal electrode is less painful and nearly as efficacious.

If in three or four weeks electrical treatment does not improve or cure the enuresis, instillations of silver nitrate may be employed. From three to five drops of a two to five per cent. solution are injected into the membranous or prostatic urethra not more than twice, a week elapsing before the second application.

Should the incontinence still persist, epidural or retro-rectal injections may be tried.

The epidural injection is made into the space between the dura and the periosteal lining of the vertebral canal. About one or two centimetres (.4 to .8 of an inch) above the intergluteal fold, is the flat triangular sacrococcygeal space, the upper limit or base being formed by the convex bulging ridge of the last sacral vertebra terminating at the lateral sacral cornua. The distance between this space and the tip of the coccyx is about six and one-half to seven centimetres (two and one-half to three inches). In stout individuals digital exploration will be necessary to determine the exact location of this space. Its mid-portion is the best site for the injection. Through a skin puncture made under local anæsthesia by a sharp-pointed tenotome the needle should be inserted to a depth of one and one-half to two inches (three to five centimetres) in the mid-line (to avoid injury to the coccygeal nerves or ganglia) and in a forward and upward direction. As the sacrococcygeal ligament is punctured, its density is readily appreciated, and thereafter the tissues hold the needle somewhat rigidly.

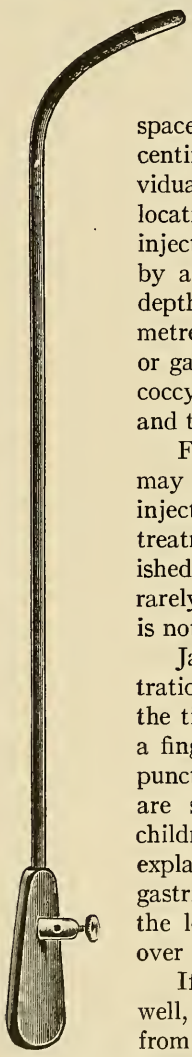


Fig. 47.—Urethral electrode.

From five to twenty cubic centimetres of normal salt solution may be given three times a week. Some cases require repeated injections. A remarkable feature in the reported results of this treatment is that excessive desire to urinate is said to be diminished and deficient desire to be stimulated. The operation is rarely painful and the treatment if carried out as above described is not likely to do harm.

Jaboulay commends retrorectal injections as simpler in administration and even more efficacious. The needle is introduced at the tip of the coccyx and passed vertically upward for two inches, a finger in the rectum guarding this portion of the bowel against puncture. Two hundred cubic centimetres of normal salt solution are slowly injected in adults—about quarter the quantity in children. Some extraordinary cures are reported, the cures being explained on the basis of a mechanical impression on the hypogastric plexus. Should this method fail, recourse must be had to the local application of electricity, and this should be continued over a long period—from six to eight months, or even a year.

If the enuresis is purely functional, many children will get well, after attention to their general hygiene, if they abstain from liquids in the evening, empty the bowels and bladder before going to bed, and rise once during the night to micturate.

Though it is customary to advise as the next means of treatment the administration of drugs, we are in general opposed to this, believing that results are more promptly attained by local treatment, provided the attendant is fairly skilful in the use of urethral instruments and recognizes the importance of thorough cleanliness in all his manipulations.

When enuresis has lasted past the age of puberty, the best results will be obtained from the use of full-calibre sounds, instillations, and possibly from epidural or presacral injections.

Incontinence with Lesions of the Urinary Tract

When enuresis is not functional, but is due to hypersecretion or to tuberculosis, for instance, the cause must receive treatment.

Incontinence without retention of urine is necessarily dependent upon a patulous condition of the sphincter. This may be caused by lodgement of an irregularly shaped stone, by which the vesical sphincter is kept open but is not occluded. This form of incontinence, Guyon states, is observed only in children.

Such a condition should be treated by pushing the stone back into the bladder and removing it by litholapaxy, or, in case this is impossible, by perineal section.

Tuberculous ulceration may infiltrate and entirely destroy the vesical sphincters, resulting in an intractable form of incontinence, the nature of which is rarely doubtful, since it develops only in the advanced stage of vesical tuberculosis.

Incontinence due to contusion or overstretching of the sphincter, such as occurs in perineal lithotrity or in digital examination of the female bladder through the urethra, may persist indefinitely. Tonicity of the sphincter muscle is best restored by the local application of electricity.

Incontinence due to fistulous opening of the bladder is elsewhere discussed.

Guyon describes under the heading urethral insufficiency a form of incontinence characterized by involuntary escape of urine caused by the slightest muscular effort, such as coughing, laughing, or straining, or even by standing. The urethra is perfectly normal. Women especially suffer from this form of incontinence, because of atonicity of the vesical sphincter. Sometimes it is seen in men after stretching of the prostatic urethra or the use of very large sounds.

Electricity supplemented by instillations is serviceable in these cases. In women, when this method of treatment fails and the escape of urine is profuse, as a last resort the urethra may be freed by dissection through the greater part of its length, given a half or a three-fourths twist in its long axis, and sewed in this position.

Incontinence of retention is the ordinary form of incontinence, and is observed particularly in those suffering from enlarged prostate or from stricture. Distinction should be made between this form of incontinence, in which the urine dribbles without either the volition or the consciousness of the patient, and the urgent, imperious urination of cystitis or of irritable bladder. The true nature of this incontinence is of course at once recognized by vesical palpation, and the nature of the obstruction is determined by the previous history and by urethral examination.

When in this form of incontinence the urethra is patulous and is of normal length, the cause must be sought in the nervous system.

As for treatment, this is directed to the relief of the retention rather than to the incontinence, and has been already discussed.

CHAPTER VII

BACTERIN AND SERUM THERAPY

As the mode of action of the tissues of the body in combating infections has become better understood, certain biological methods have been evolved to increase and direct their activity.

Two quite different methods are available. By the use of bacterins, or vaccines (the various tuberculins being here included in the term for the sake of convenience), the tissues are stimulated to the production of bodies inimical to the bacteria; by the use of sera substances inimical to the bacteria are added to the body. Therefore the object of bacterin therapy is to produce an active resistance, while the administration of sera is for the purpose of conferring a passive immunity. The selection of the remedy to be employed depends in part on the condition of the patient and the effect desired, and in part on the availability of the desired preparation.

BACTERINS

Bacterins are suspensions of killed bacteria, so made that the preparations are of a convenient strength for hypodermic administration. An antiseptic is usually added.

The purpose of the administration of bacterins is to increase the natural bactericidal power of the body against the particular infecting germ. This bactericidal power lies in what are known as antibodies, or as *immune bodies* when they are produced specifically against a particular antigen (the infecting bacterium).

These immune bodies are of various kinds, the kinds varying with the requirements of the body in meeting the attack of the particular infecting germ. Antitoxins neutralize the poisons generated by the bacteria. Agglutinins cause certain motile bacteria, as the typhoid bacillus, to lose their motility and become clumped. Lysins, or bacteriolysins, immune bodies of great practical importance, cause the solution of bacteria. Opsonins are constituents of the blood-plasma which prepare the bacteria for phagocytosis by the leucocytes. Except bacteria be acted upon by opsonins, their ingestion by the leucocytes is negligible.

The hypodermic administration of bacteria in appropriate dose causes an increment in the production of all these immune bodies, but, on account of the comparatively greater ease with which it can be determined, the increase or decrease in opsonic activity is usually taken as the measure of bacterial resistance.

The Opsonic Index.—The consumption of bacteria by the leucocytes is proportional to the activity of the opsonins which act on these microörganisms, preparing them for leucocytic phagocytosis. The opsonic index, one of the ways of estimating the effect of bacterin therapy, is a comparison of the phagocytic power of leucocytes upon bacteria acted upon by the patient's serum (that is, the patient's opsonins) with the activity of these cells when serum from a normal person is used in the experiment. The index is obtained by dividing

the number of bacteria found within a certain number of leucocytes when the patient's serum is used by the number in an equal number of leucocytes when normal serum is employed. Therefore if the patient's opsonic power be less than normal, the index is less than 1, as 0.75, while if it be greater than normal the index is greater than 1, as 1.25.

After a bacterial injection there is commonly a drop in the index, followed by a rise. The drop is spoken of as the negative phase, and when well marked is evidenced clinically by lassitude, headache, loss of appetite, bodily aches, rise of temperature, occasionally a chill, and inflammatory reaction in the affected region and at the site of injection; the rise is spoken of as the positive phase, and is denoted clinically by progressive improvement in the local condition. The object striven for in the treatment is to incur as slight a negative phase as possible, while inducing a well-marked positive phase. Practically, it is usually possible to treat a case in a thoroughly satisfactory manner without resorting to the rather laborious technique of the estimation of the opsonic index.

Immune bodies are specific for the bacterium used as antigen, and for that particular strain of that bacterium. It is therefore essential in selecting a bacterin preparation to have one containing the infecting organism. In some cases this can be satisfactorily accomplished by using a vaccine containing a large number of strains. However, the utilization of mixed bacterins, and even of polyvalent preparations, necessarily is accompanied by the performance of much useless work on the part of the tissue-cells in producing unneeded immune bodies, so that for this reason, as well as because of the greater certainty of obtaining the proper organism, autogenous bacterins (that is, those prepared by culturing the germ infecting the patient to be treated) are to be preferred to the stock article made up from cultures obtained from other sources.

Yet in the case of certain organisms difficult of culture, as the gonococcus and the tubercle bacillus, the use of stock preparations is the only practical one, and usually gives satisfactory results.

Dosage.—The more virulent the organism, and the more frail and sick the patient, the smaller should be the initial inoculation, and the more cautious the increase in subsequent doses, which are usually given at intervals of from three days to a week.

To be more explicit, the initial dose of such organisms as the *Streptococcus,* the *Gonococcus,* the *Bacillus of Friedländer,* and the *Bacillus coli* should be small, from 5 to 50 million. The first dose of the *Staphylococcus,* the *M. catarrhalis, B. pseudotuberculosis rodentium,* etc., may be from 25 to 100 million. If the first dose causes no reaction, the second may be twice as great, the third double the second, the fourth three times the second, the fifth four times the second, and so on. If any of these injections should give rise to a reaction, the next dose must not be given till this has entirely subsided, and must be no larger, generally smaller, than the dose which caused the disturbance. Otherwise the dosage may be steadily increased till 500 to 1000 million are being given, and the patient is proceeding in a satisfactory manner. Determinations of the opsonic index from time to time, when this is feasible, are of much value in determining when inoculations should be discontinued, by showing the attainment of a satisfactory degree of immunity.

It is also to be remembered that a diseased condition may be due to more than one bacterium, and that one bacterium may disappear and another take its place during the course of treatment. It is therefore desirable that repeated cultures be made when patients do not improve in an entirely satisfactory manner.

Indications.—Bacterin therapy is particularly indicated in subacute and chronic localized infections. When the infection is acute there is usually sufficient absorption to cause an abundant elaboration of immune bodies if the tissues are capable of responding to the stimulus, and a therapeutic injection is apt to increase the already existent negative phase.

Bacterin therapy is to be considered as an adjuvant to surgical treatment; rarely is it a substitute therefor. Its uses may be summarized as follows:

Bladder and Kidney.—In cystitis, pyelitis, and to a less extent in pyelonephritis and in pyonephrosis, bacterins are of value. Organisms which have been isolated are the *Bacilli coli, tuberculosis, pseudotuberculosis rodentium, acidi lactici, typhosus,* the *Bacillus of Friedländer,* the *Corynebacterium pseudodiphtheriticum, Streptococci pyogenes,* and *Septicæmia hæmorrhagica, staphylococci, gonococcus,* and *micrococcus lanceolatus.*

Prostate and Seminal Vesicles.—Though the gonococcus is the usual primary cause of inflammation of these organs, this organism has associated with it other bacteria at a comparatively early stage of the disease, the added infection coming either from the urethra or through the blood. Immunization must therefore consist in the administration of gonococcus bacterin, usually a stock preparation made up from several strains, and an autogenous vaccine, made up by culturing the expressed secretions.

Among the organisms which have been found are the *Micrococci aureus, albus, citreus, candicans, candidans,* and *orbicularis,* the *Bacilli typhosus, pyocyaneus,* and *acidi lactici,* and the *Corynebacterium pseudodiphtheriticum.* New cultures must be made from time to time, and fresh bacterins prepared as the bacterial flora changes.

Epididymitis.—In the acute stages antigonococcus serum is indicated rather than bacterin; the latter (gonococcus) may be used in cases showing a tendency to run a protracted course, with frequent recurrences.

Urethritis.—The results of bacterin treatment of gonorrhœal urethritis have not been encouraging. However, Laird * has found that the use of autogenous bacterins, not of the gonococcus but of the other organisms found in the discharge, materially lessens the intensity of the posterior symptoms, and the duration of such complications as prostatitis and vesiculitis.

Vulvovaginitis, in young children, is better treated by bacterins than by local applications. In the acute cases a polyvalent gonococcus bacterin should be used; the initial dose of about 5 million should be cautiously increased at intervals of from four to seven days till 50 or 100 million are given. In the chronic cases it is often useful to supplement the gonococcus preparation with autogenous bacterins containing organisms which have become associated with the gonococcus.

In older girls (that is, those over ten or fourteen years) and in women bacterins seem to have little or no effect.

* Personal communication.

TUBERCULIN

Tuberculin may be used both as a diagnostic and as a therapeutic agent.

Tuberculin in Diagnosis

Two principal methods are employed, the subcutaneous method of Koch, and von Pirquet's method by scarification. In both methods Koch's Old Tuberculin ("O. T."), a filtrate of a concentrated bouillon culture of tubercle bacilli, containing, therefore, the toxins of the bacteria, is used.

The subcutaneous method is the one usually to be preferred, as with it, by the focal reaction, it is possible to be assured that the lesion of which the patient complains is the one producing the reaction, and that some unsuspected, inactive lesion is not responsible.

It is customary to observe the patient for some days before the test is applied, having the temperature taken at frequent intervals to ascertain its usual variations. The test is not applicable in patients running a marked febrile course, in general miliary tuberculosis, acute or advanced phthisis, tuberculous meningitis, or in markedly asthenic individuals or convalescents from acute illness; in the latter conditions a reaction may not be produced. Under the circumstances mentioned the von Pirquet reaction should be selected.

A dose of 0.5 milligramme (0.05 mg. in children) is first given. A positive reaction is understood to consist in a rise of temperature of at least one degree Fahrenheit, an increase in symptoms (focal reaction), and usually some irritation at the site of injection (local reaction). If no reaction is produced, successive doses of 1.25 mg., 2.5 mg., and 5.0 mg. in adults and 0.2 mg., 0.5 mg., and 1.0 mg. in children are given at intervals of three to five days. Should there be doubt as to whether a reaction occurred, when all has become normal the dose last given should be repeated, it being inadvisable under such circumstances to increase the amount lest a severe reaction be produced, the patient having been sensitized by the preceding injection.

This method of using tuberculin diagnostically has been very reliable both in its positive and in its negative findings.

Von Pirquet Reaction.—Two drops of O.T. are placed on the arm, after cleansing with ether, and the skin gently scarified through the drops; usually a drop of sterile bouillon is placed between the drops of tuberculin to act as a control, and the skin beneath it similarly treated. All are allowed to dry in the air. A typical positive reaction consists in the production of a hyperæmic and inflammatory area from four millimetres to three centimetres in diameter. But a single papule may be present, or there may be numerous papules, or there may be a markedly indurated zone exuding serum.

This test merely indicates the presence of a tuberculous focus in the body, but does not direct attention to its location.

TUBERCULIN THERAPY

The indications for the use of tuberculin as a therapeutic measure are:

Renal tuberculosis when bilateral, and when unilateral if the opposite kidney is not functionally sufficient to care for the needs of the body.

Vesical and ureteral tuberculosis, after removal of the primarily affected kidney, or when the renal lesion cannot be extirpated, or when the bladder is the primary seat of the infection.

Prostatitis and Seminal Vesiculitis (tuberculous).

Epididymitis, in the presence of other more extensive tuberculous lesions of an irremovable character.

The preparations usually used are Bacillen Emulsion ("B. E."), a suspension of a finely-pulverized virulent culture of tubercle bacilli, and Tuberculin Rückstand ("T. R."), an extract of a dried pulverized virulent culture. Tuberculinum Purum ("T. P."), a purified Old Tuberculin, is sometimes used on account of its nontoxic character, and the speed with which the dosage can be increased.

B. E. and T. R. are given in initial doses of 0.0001 to 0.001 milligramme. These doses are doubled at intervals of three to five days, later at intervals of a week to ten days, provided no reaction is excited. Should the slightest reaction occur the treatment must be suspended till two or three weeks have passed after the reaction has subsided, after which the injections may be recommenced, but in doses one-hundredth or one-thousandth of that which caused the disturbance.

After a large dosage has been attained, usually as a result of six months' to a year's treatment, it is well to discontinue the injections for a time, resuming them if they seem again necessary.

Tuberculin treatment is contra-indicated in the presence of a considerable degree of fever and in markedly asthenic patients; also in general miliary tuberculosis. During the treatment the patient must be carefully observed as to febrile reaction, general health, and body weight, as well as to the effect upon the local condition.

SERA

Specific sera are produced by immunizing certain of the lower animals, usually the horse, either to bacterial toxins or to the bacteria themselves. The immunity produced by their injection into patients is of the passive type, and is transitory in its action. Sera are particularly useful in the acute stages of infections.

The only specific serum used specially in genito-urinary surgery is that prepared against the gonococcus. Rogers and Torrey, the originators of this serum, first employed rabbits for its production. Rams and horses have since been used, their serum being less likely to produce anaphylactic phenomena. The dose has been increased from the 2 c.c. originally recommended till at present from 5 to 100 c.c. are commonly administered, the dose being repeated daily or less often as indicated. The virtue of the serum lies in its contained immune bodies, particularly bacteriolysins.

The acute metastatic gonorrhœal affections, arthritis, endocarditis, etc., are the lesions in which antigonococcic serum is most useful. It has also seemed at times to be helpful in acute epididymitis, but not in urethritis or prostatitis. The injections may be made into any convenient part; the abdominal wall and back are usually selected for the larger quantities.

NORMAL SERUM

For the control of hemorrhage, as from the bladder or kidney, the subcutaneous or intravenous injection of normal serum, equine or human, is more potent than any other agent. The serum should be given freely, 20 c.c. being the minimal and 100 c.c. the maximal dose, repeated according to indications.

CHAPTER VIII

SURGERY OF THE PENIS

ANATOMY OF THE PENIS

The penis in size bears less constant relation to general physical development than does any other organ of the body. Its average length is about three inches when in the flaccid condition and twice that when erect; its circumference when it is flaccid averages about three inches. It is made up in the main of erectile tissue. This is separated into three distinct compartments by investments of tough fibrous tissue. (See Fig. 48.) The bulk of the penis is formed by the two corpora cavernosa lying side by side and capped by the glans, which is a continuation of the corpus spongiosum. The corpus spongiosum, much smaller in circumference than either of the cavernous bodies, lies in the angle formed by their apposition, bearing to them the relation that a ramrod does to the double barrel of a gun.

The cavernous bodies arise from the tuberosity and ascending ramus of the ischium on each side, and pass upward, forward, and inward until they become closely apposed to each other beneath the pubic symphysis. They are then continued forward, each in a fibro-elastic sheath (tunica albuginea), which in front does not form a complete partition between the two (septum pectiniforme). They terminate in blunt extremities, which are capped by the glans (Fig. 49).

The spongy body—composed of erectile tissue and also invested by a fibroelastic sheath—is made up of a central portion of comparatively small diameter, through which the urethra passes, with an expansion at each end, the glans penis, capping the cavernous bodies, and the bulb, lying in the angle formed by the two convergent crura of the cavernous bodies, and attached to the lower surface of the triangular ligament. The flange-like expansion at the base of the glans is termed the corona, and the depression behind this is called the cervix, or coronary sulcus.

In addition to the tough fibroelastic sheath with which the spongy and cavernous bodies are each supplied, there is a sheath, termed Buck's fascia, or the fascia of the penis, which binds these structures together. This covers in the two rounded extremities of the corpora cavernosa and is firmly attached to the base of the glans penis. Passing backward as a complete investment of the body of the penis, it is continuous with the suspensory ligament above and with the deep layer of the superficial fascia below. Superficial to this fascia lies an extremely loose layer of areolar tissue without fat, containing a thin layer of muscular fibres (dartos).

The thin movable skin covering the penis is usually continued forward till it partly or completely covers the glans; it is then doubled back upon itself, is attached to the cervix, and is continued forward over the glans penis till it joins the mucous membrane of the urinary meatus. This reduplication is termed the prepuce, or foreskin. It passes forward as a tough fibrous band, called the

frænum, from the lower central part of the coronary sulcus to just beneath the urinary meatus. At the preputial orifice the subcutaneous layer is especially well developed, often forming a tough fibrous ring. The inner surface of the prepuce and the covering of the glans penis are moist, thin, and more like mucous membrane than like ordinary skin. On the flange-like expansion of the glans, particularly on its anterior aspect, are placed the glands of Tyson, which secrete a cheesy substance, termed smegma; this, when it undergoes decomposition, has a characteristic offensive odor.

The suspensory ligament of the penis is a strong, triangular, fibro-elastic band attached to the front of the pubic symphysis and to the two cavernous bodies at their angle of junction.

The muscles of the penis are the erector penis or ischiocavernosus, the accel-

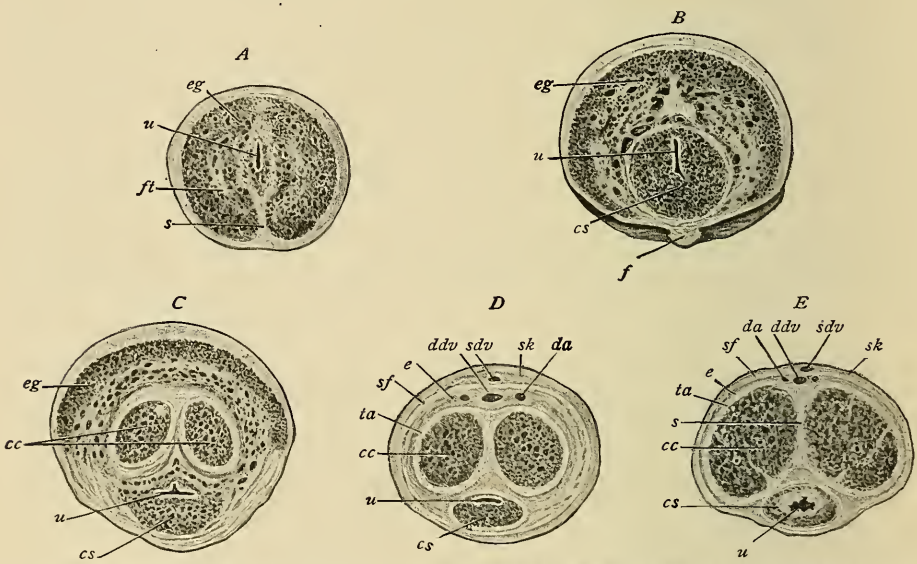


FIG. 48.—Cross sections of formalin-hardened penis at different levels. *A*, through glans, near tip; *B*, about middle of glans; *C*, through corona; *D*, body, distal part. *E*, body, proximal part. *cc*, corpus cavernosum; *cs*, corpus spongiosum; *da*, dorsal artery; *ddv*, deep dorsal vein; *e*, fibrous envelope; *eg*, erectile tissue of glans; *f*, frænum; *ft*, fibrous tissue; *s*, fibrous septum; *sdv*, superficial dorsal vein; *sf*, superficial fascia; *sk*, skin; *ta*, tunica albuginea; *u*, urethra. (Deaver.)

erator urinæ or bulbocavernosus, and the unstriped muscular fibres of the erectile tissues and of the urethra.

The erector penis muscles are more concerned in exercising pressure upon veins, and thus increasing turgescence, than in mechanically altering the position of the penis. They arise from the ischiatic tuberosities and are inserted in the lower side of the fibrous sheath of the corpora cavernosa.

The bulbocavernosi arise from the central perineal point, and, passing upward and forward, encircle the bulb and posterior part of the spongy body. The action of these muscles is to expel by their contraction the last drops of urine and to drive forward with force the semen when it passes from the posterior urethra.

The dorsal arteries of the penis, two in number, run forward through the suspensory ligament on each side of the dorsal vein to the glans and prepuce, also giving branches to the cavernous bodies. The arteries of the corpora cavernosa give the main blood supply to the erectile tissue of the cavernous bodies. The artery of the bulb gives the main blood supply to the corpus spongiosum. All these vessels are derived from the internal pudic. In addition, there is a collateral supply due to an anastomosis of the same vessels with branches of the external pudic.

The dorsal vein of the penis is the largest efferent vessel of this organ;

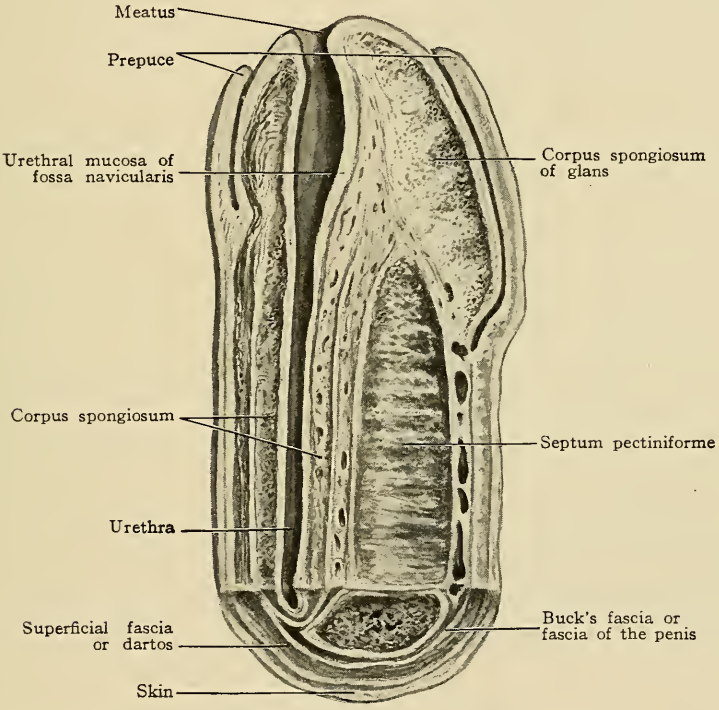


FIG. 49.—Structure of the penis.

it passes backward in a groove on the dorsum of the penis through the suspensory ligament and into the prostatic plexus; the smaller veins nearly all pass backward, pouring their blood into the same plexus.

The nerves of the penis are derived from the internal pudic (the dorsal nerve of the penis) and from the hypogastric plexus (nervi erigentes to the erectile tissue).

The lymphatics pass partly to the inguinal region, particularly those of the glans, the foreskin, the surface of the penis, and the anterior part of the urethra, partly to the deep pelvic lymphatic system.

The tensile strength of the penis, because of its tough fibrous investments, is sufficient to bear the entire weight of the body. The fibrous investment of the blunt extremities of the two cavernous bodies where they are capped by

the glans delays, and sometimes prevents, the backward extension of inflammatory or infiltrating processes, particularly cancerous infiltration, which primarily involve the glans. This fibrous sheath, being a continuation of the deep layer of the superficial fascia, also limits the forward extension of urinary and purulent infiltrations beneath this fascia, such infiltrations sparing the glans.

The free blood supply of the penis and the rich innervation of the organ insure rapid healing in case of wounds, and justify conservative treatment even though it has been nearly severed or extensively crushed.

The lymphatic vessels, passing as they do to both the inguinal and pelvic nodes, carry infection in both directions. In case of malignant disease with involvement of the nodes of the groin, removal of the disease together with these nodes, though it gives no assurance against deep recurrence, is indicated, since the inguinal is often an earlier involvement than the pelvic.

The lax vascular subcutaneous tissue readily becomes œdematous either from local or from general causes, especially in the region of the foreskin.

The delicate, richly innervated skin is extremely sensitive to irritants.

ANOMALIES OF THE PENIS

These are rarely observed unassociated with other malformations. The penis may be absent, concealed, minute, gigantic, double, twisted, or adherent. A large percentage of those thus afflicted are mentally deficient.

Absence of the Penis.—Of this anomaly, unassociated with other deformities, nine cases have been reported. In one case the urethra opened into the perineum, in the others just within the anal sphincter. Demarquay's patient had reached the age of twenty-seven when he developed an acute orchitis. The urethra opened into the anus, just anterior to which was a small, wart-like projection of erectile tissue. Venereal excitement caused this tissue to become turgid, and, if sufficiently prolonged, was followed by escape of semen through the urethra. The small bifid scrotum simulates the conformation of the female, the deformity constituting male pseudohermaphroditism (see p. 96). Harris notes that the sex can be determined by observing the nature of the upper margin of the pubic hair, this being a straight transverse line in the female, while in the male it extends upward near the median line.

Concealed Penis.—Absence of the penis may be seeming only, the organ being concealed beneath the surface. In one such case an incision freed the organ and enabled the infant, who was suffering from retention of urine, to pass his water.

Treatment of the malformation is usually unnecessary on account of the relative greater severity of concomitant deformities. When, however, there is a chance for survival, opportunity should be taken to search thoroughly for a concealed rudimentary penis. This, if found, should be dissected free and, by plastic operation, covered with integument derived from the surrounding parts.

Micropenis.—Arrested growth of an otherwise perfectly formed penis is by no means uncommon, though this rarely produces results so marked that the condition may be termed anomalous. A flaccid adult penis less than two

inches in circumference and two and a half inches in length is abnormal, though even in such a case the erectile tissue may be dilatable to an unusual degree, thus making the organ normal in size when in a condition of physiological activity. In some reported cases the penis has varied in size from that of a quill to that of the last two joints of the little finger.

As seen in adults, stunting of the penis is perhaps more commonly due to excessive masturbation or to other causes interfering with development than to congenital defect.

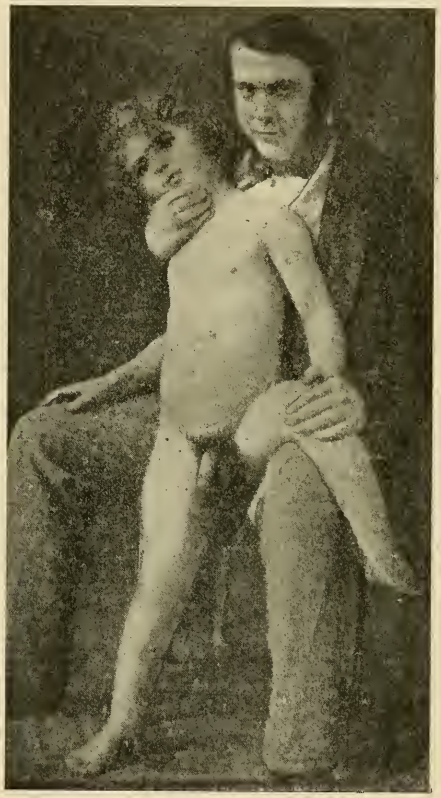


FIG. 50.—Precocious sexual development. (From Mutter Museum, College of Physicians, Philadelphia, Pa.)

Treatment.—A minute penis when observed at birth or shortly after does not require treatment, except for the relief of preputial adhesions or of tight phimosis, since the organ, as is the case with the testicles, may before puberty, or about this time, grow rapidly and attain normal dimensions. A tight foreskin should be removed, and any abnormal condition interfering with local growth should be remedied.

When the condition is observed soon after puberty, or in the young adult, the prospect for ultimate growth is by no means hopeless. In these cases physiological activity of the part is at times followed by a rapid growth till normal size is reached.

For the purpose of developing a stunted penis a suction apparatus has been employed. The penis is slipped into a large cylinder fitting closely around the root of the organ; from this cylinder the air is partly exhausted by means of a rubber bulb. This causes congestion, distention of the erectile tissue, and, it is asserted, permanent enlargement. Such a treatment to be efficient would have to be long continued.

Megalopenis.—In congenital imbeciles the penis is often of unusual size, and in dwarfs and hunchbacks it is not uncommonly developed not only out of proportion to the other parts of the organism, but even beyond the average for individuals of normal growth; this is also noted in precocious puberty (Fig. 50).

Hypertrophy of the penis may be a source of danger, since an excessive development predisposes to abrasions and fissures through which inoculation with venereal diseases may occur.

Double Penis.—A few authentic cases illustrative of this anomaly have been reported. The two organs are usually placed side by side, and there are other evidences of monstrosity by fusion. In at least two reported cases each

organ was functionally perfect (Fig. 51). In partial division of the penis but one portion of the organ may be traversed by an urethra; division of the urethra is never carried farther back than the prostatic region. Olsner's case urinated from one penis and ejaculated semen from the other.

Torsion of the penis, or a twisting of the organ on its long axis so that the frænum looks forward, is extremely rare, unless hypospadia or other malformation is present. Urination and ejaculation of the semen are not materially interfered with; hence treatment would be indicated only from a cosmetic standpoint.

Adherent Penis.—Rarely, as an isolated anomaly, the penis is found adherent to the scrotum through nearly its whole extent. This materially interferes with function, and should be remedied by freeing the organ, so cutting flaps that the raw surface may be covered.

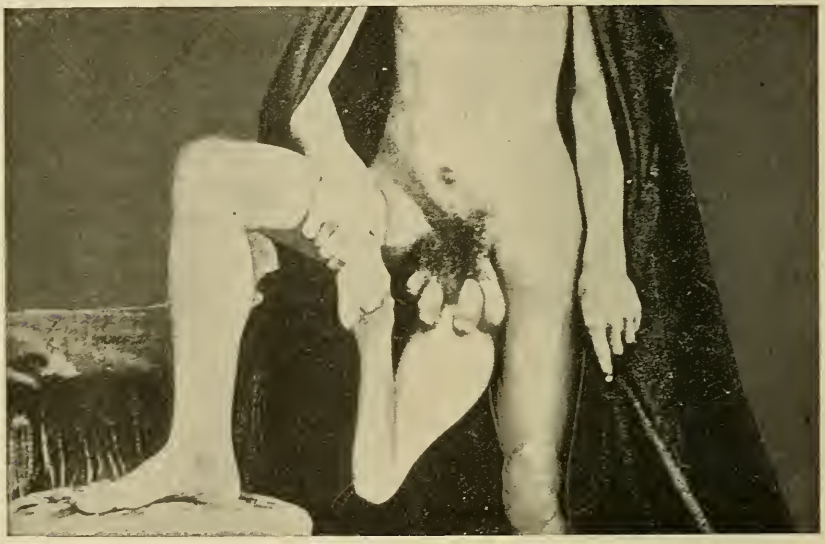


FIG. 51.—Double penis.

Hermaphroditism implies the possession of both testicles and ovaries. The deformity is so rare that its very existence has been denied. Auto-impregnation has never been observed.

Pseudohermaphroditism, in which an individual of one sex simulates in genital conformation that of the other, is a relatively common condition. In males the penis is atrophic, the scrotum bifid, there is perineal hypospadias, and the testicles are undescended; females exhibit hypertrophy of the clitoris (Fig. 52) and absence of vagina, or great reduction of the size of this canal, while the uterus and ovaries may be so small that their palpation *per rectum* is difficult or impossible. The determination of sex must in part be based on the nature of the genital organs, and in part on extragenital sexual characteristics, as the general conformation of the body, distribution of hair, development of the breasts, and tone of the voice; but simulation of the opposite sex often extends even to these.

Treatment of this condition is indicated only for cosmetic purposes, or for making sexual approach possible.

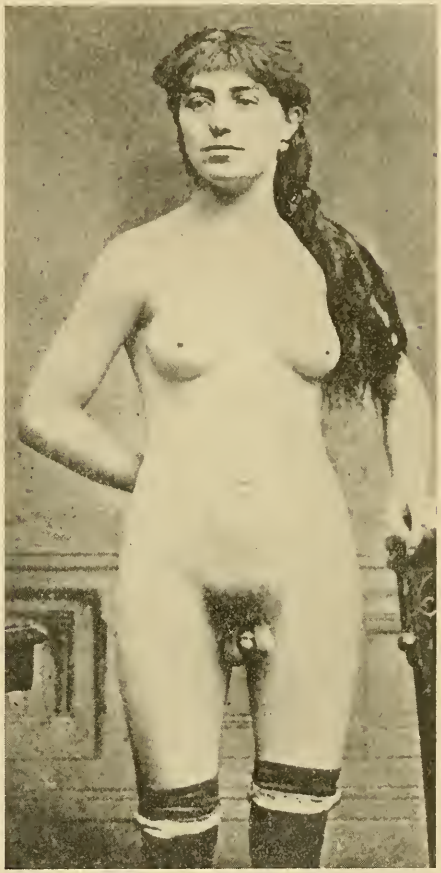


Fig. 52.—Hypertrophy of the clitoris. Ovaries in the labia majora between which is the vaginal opening. (From Mutter Museum, College of Physicians, Philadelphia.)

ANOMALIES OF THE PREPUCE

The foreskin may be absent, incompletely developed, redundant, or adherent to the glans; the preputial orifice may be absent or extremely small; the frænum may be abnormally short.

Absence or incomplete development requires no treatment, nor does redundancy urgently demand surgical intervention, except where it is complicated with phimosis and an irritated or inflammatory condition of the glans.

Adhesions between the glans and the inner surface of the prepuce are present in many infants. They may be the result of a balanoposthitis, but are usually congenital and associated with phimosis.

Adhesions may appear in the form of comparatively narrow bridles or bands, or may involve broad areas. Commonly the symphysis is limited to the corona, and is so tight that in the operation for circumcision the line of adhesion is frequently taken for the normal line along which the mucous membrane is reflected behind the glans, and thus the coronary sulcus is not freed of the retained smegma so habitually found here in such cases. Exceptionally the whole surface of the glans adheres to the foreskin, the lips of the meatus alone being free. Adhesions between the foreskin and the glans exceptionally act as sources of reflex irritation, causing nervous phenomena of a convulsive or paralytic type. Children in whom the adhesions are tightest and most extensive commonly exhibit a penis below the average size. In the adult such adhesions, at least as congenital deformities, are rare, since the bond of union is easily torn by slight mechanical interference. Occasionally the bands are so tough that nothing short of section can free them.

The *treatment* of adhesions between the glans and the foreskin is in ordinary cases readily carried out. Phimosis having been relieved, either by stretching the preputial orifice or by circumcision, stripping back should be practised till the coronary sulcus is freed through its whole extent, usually exposing a ring

of smegma. Daily retraction, washing, and the application of a bland ointment should be continued till the inflammation resulting from the stripping has subsided.

Obliteration or occlusion of the preputial orifice may not be detected directly after birth, but cannot long escape attention, because of failure to pass water and the formation of a tumor at the end of the penis, due to distention of the preputial sac with urine. Demarquay, however, reports a case of four months' standing with a prepuce distended to the size of a bladder.

The *treatment* is circumcision.

Narrowing of the Preputial Orifice—Phimosis

The term phimosis implies that the preputial orifice is too small to allow retraction of the foreskin behind the glans. The opening may be so small that a probe will pass with difficulty. Phimosis may be congenital or acquired.

Congenital Phimosis.—This condition, present in the great majority of male infants at birth, usually causes no symptoms, and spontaneously disappears at about the age of seven. Exceptionally the narrowed orifice is a cause of continued or recurring inflammation, characterized by balano-posthitis, warts, fissures, and ultimately adhesions, or by obstruction to the free flow of urine, resulting in not merely local inflammation and exceptionally preputial calculi, but giving rise to vesical irritability and its attendant consequences. Moreover, certain reflexes have been attributed to phimosis, among which may be named retention or incontinence of urine, arrested development of the penis, precocious sexualism, seminal weakness, spastic palsies, simulated hip-joint disease, muscular incoördination, convulsions, colic, indigestion, night terrors. When there are distinct evidences of local irritation associated with symptoms of general nerve disturbance, the possibility of a relation between the latter and the phimosis must be carefully weighed.

Acquired Phimosis, when permanent (*i.e.*, cicatricial), differs from the congenital form in that the redundant skin lying in front of the preputial orifice is usually wanting, and the margins of the latter are felt as a more or less irregularly indurated band or circle, which instead of rolling back on attempts at retraction slowly stretch, tightly embracing the glans.

When temporary, acquired phimosis is due to swelling, usually inflammatory or congestive.

Treatment.—Permanent phimosis, whether congenital or acquired, should be treated by operation whenever it is responsible for local or reflex symptoms. As a prophylactic against gonorrhœa, chancroid, chancre, and cancer, the operation is desirable, even when the condition excites no trouble.

The treatment of temporary phimosis due to inflammatory swelling will be described when considering the various affections which may produce this condition.

The operation of choice is circumcision.

Stripping back is applicable only in the congenital form of phimosis. It is accomplished by pressing the skin of the penis back toward its root with the tips of the middle and ring fingers, which are then used to steady the organ while the foreskin is manipulated with the index-fingers and thumbs. The manipu-

lations consist in pressing back the skin firmly till the glans emerges through the preputial opening. Adhesions may be broken up with a probe or finger-nail, or more easily by grasping the glans, as soon as sufficiency of it is exposed, with the thumb and forefinger covered with a single layer of gauze, catching the prepuce in a similar manner, and tearing one from the other. It is of the utmost importance that the whole of the glans be freed. The raw surfaces are then washed with weak bichloride solution (1 to 6000), dried, well greased with boric ointment, or olive oil, and the foreskin drawn forward. The foreskin must be retracted for washing and dressing daily for ten to fourteen days, preferably by the physician.

Circumcision

This operation is indicated in every case of phimosis in children. In the absence of phimosis circumcision is also indicated where there is a tendency to the formation of venereal warts, or to prolonged attacks of balanoposthitis, to recurrent herpes progenitalis, to fissurings and erosions during intercourse, to hypersecretion on the part of Tyson's glands, to sexual erethism without evident cause, to apparently causeless functional disturbances of the bladder, such as nocturnal enuresis, and to masturbation.

In preparing for operation the parts are thoroughly washed with hot soap-suds, the preputial sac being cleaned by means of injections of 1 to 40 carbolic in 1 to 4000 sublimate solution. The ordinary antiseptic precautions are observed. The penis is passed through a small opening made in the centre of a sterilized towel, and the latter is then spread out, thus preventing the wound surface from coming in contact with the skin.

A general anæsthetic should be given to boys less than twelve years of age; older children, when not of an unusually nervous disposition, and adults can be operated upon painlessly under a local anæsthetic. For the induction of anæsthesia half an ounce of 0.25 per cent. solution of novocaine in half-normal saline, to which have been added one or two drops of suprarenalin solution (1 to 1000), should be sterilized by boiling. The solution must be prepared immediately before use. The nerves to the outer layer of the prepuce may be blocked by injecting 20 to 30 minims of the solution *beneath* the skin at three equidistant points about the base of the penis (Fig. 53). The nerves to the inner layer of the prepuce may be caught either by an intradermal infiltration as close to the corona as the needle can be inserted (applicable to cases in which retraction is possible), or by injecting from 30 to 60 minims into the inner, upper quadrant of each corpus cavernosum; anæsthesia by this method is not invariably perfect in the region of the frænum, and the passage of the needle through the tunica albuginea causes some pain in most cases, so that when applicable the former method is the one of choice. Five to fifteen minutes are required for the novocaine to take effect; anæsthesia lasts forty-five to sixty minutes.

The operation is begun by marking the skin as it lies without traction over the bulge of the corona and the notch of the frænal attachment to the glans by nicking it with scissors; if phimosis forceps are not to be used, additional nicks should be made, one on each side, midway between the first marks. The prepuce is now retracted, the orifice being cut if this be necessary to secure exposure

of the glans, adhesions to the latter are separated, and the coronary sulcus, containing in infants dry, cheesy matter, is fully exposed and thoroughly cleansed. The foreskin is then drawn forward and is split dorsally and cut away to either side along the line indicated by the nicks, using these alone as a guide, or amputated through the slot of a phimosis forceps applied in the direction indicated, from above downward and forward, the skin being drawn forward and the glans pushed back as the forceps are tightened. There will be left, if phimosis forceps have been used, the inner layer of the foreskin, and often the preputial orifice with a ring of true skin about it. The inner layer is next removed by slitting it dorsally with scissors to within one-sixth of an inch of its attachment to the corona, and then trimming off each side, leaving that width of the inner

FIG. 53.—Blocking superficial nerves of penis.

layer. Bleeding must be completely stopped by twisting the vessels or by tying them with fine catgut.

Suturing is done with No. 0 plain sterile catgut, the first suture being of the mattress variety and placed at the frænum so as to make a neat approximation at this point. Accurate apposition is secured by inserting from two to four continuous sutures, according to the size of the penis, the first stitch of each being inserted before any of them are completed (the order of insertion in a four-suture operation being ventral, dorsal, right lateral, left lateral).

For the juvenile and adult a narrow bandage of dry sterile gauze is applied about the line of suture with sufficient firmness to insure against oozing. In clean cases this dressing need not be changed for two to five days unless it should become dirty or too tight. Prolonged soaking in a dilute antiseptic solution, supplemented by a peroxide spray, facilitates its removal. Infants are dressed with sterile gauze thickly smeared with boric ointment, held in place by the diaper and changed as frequently.

Œdematous swelling coming on after the operation is completed or even during its course is commonly due to the use of irritant antiseptics, though it may occur without assignable cause. It subsides, in part at least, in from one to two days under elevation, the application of evaporating lotions (dilute alcohol and lead water equal parts), and the administration of a brisk purgative. It may persist for months in the form of a semi-solid œdema about the frænum. Its disappearance is hastened by stimulating and absorbent ointments, such as thyol or ichthyol ten parts, and lanolin ninety parts.

Infection calls for the removal of sufficient sutures to give adequate drainage, elevation of the part, and the application of dressings kept wet with dilute alcohol and water equal parts and frequently changed.

Interference with Erection.—This results from the removal of too much skin, and is to be avoided by carefully marking the skin before applying the clamp. Owing to the great extensibility of the skin, the ultimate prognosis is good; at times the frænum will require division.

Recurrence of the Phimosis.—When too much of the mucous layer of the foreskin has been left, phimosis may recur in a more severe form than that for which the original operation was undertaken, the cicatricial tissue along the line of suturing sometimes contracting very rapidly. A strip of mucous membrane wider than a fourth of an inch should never be left. If narrower than a sixth of an inch, it is somewhat difficult to insert the sutures satisfactorily.

Paraphimosis.

When the prepuce has been retracted behind the glans and cannot again be brought forward, the condition is termed paraphimosis. The exciting cause is usually a more or less forcible retraction of a tight foreskin, though occasionally inflammatory swelling will cause the foreskin to roll back.

In gonorrhœa, chancroid, chancre, balanoposthitis, and all lesions of the genitalia attended by swelling of the foreskin, this complication is particularly liable to occur. It is most frequently observed in children as a result of manipulation of the parts.

When a narrow preputial orifice is drawn behind the corona the constriction it exerts upon the parts causes rapid swelling. The glans becomes enlarged and glossy. It is often partially concealed by a thick collar of shiny, œdematous mucous membrane, behind which there is a deep, excoriated sulcus, and back of this sulcus there is usually a second œdematous band less marked than the one lying immediately behind the coronary sulcus. The penis seems to have a distinct upward kink or bend just behind the glans, this appearance being due to the deep notch caused by the margin of the retroverted preputial orifice of the penis, and to the œdematous swelling which is particularly marked about the position of the frænum. In some cases, where the tense, inelastic edge of the orifice exerts a more than usual amount of constriction, circulation is markedly interfered with, and ulceration and even sloughing involving both the foreskin and the head of the penis may take place.

When the swelling consequent upon paraphimosis is well developed (Fig. 54) there is encountered first a furrow (*a*), the coronary sulcus, which is normally found behind the corona; in these cases it appears deeper because it is intensified by the œdematous swelling. Covering this furrow, and even overlapping the

glans somewhat, is a shiny, œdematous collar of mucous membrane (*b*). This is that portion of the prepuce which is normally in contact with the posterior face and border of the corona. Behind this swollen fold is found a second deep, often ulcerated furrow (*c*); this is the actual seat of constriction, and behind it is placed yet another ridge of swollen integument (*d*).

Paraphimosis is attended with very severe pain, which does not intermit until the constriction has been relieved, either by operation or by the process of ulceration. Where surgical interference is delayed, or has not been successful

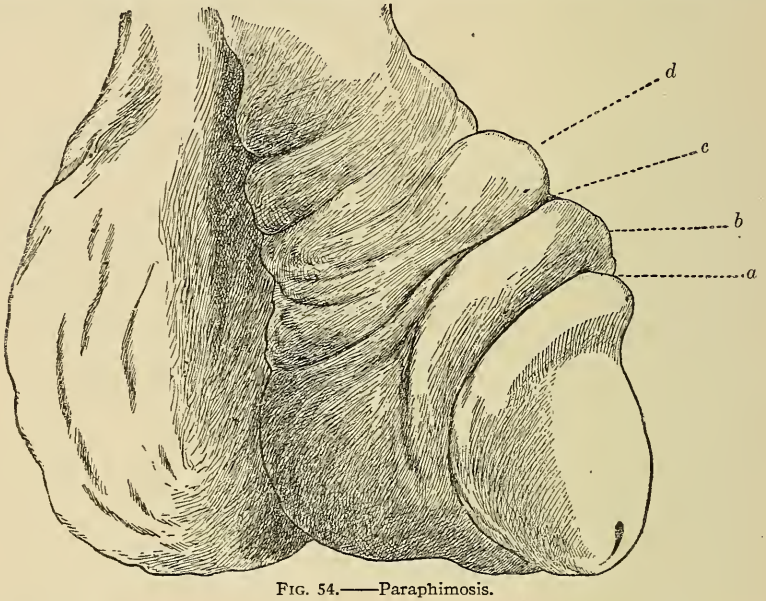


FIG. 54.——Paraphimosis.

in remedying the trouble, the subsequent cicatricial contraction may occasion great deformity.

Treatment.—When a paraphimosis is due to inflammatory swelling and causes no harmful constriction, its existence may be ignored.

As a general rule, however, paraphimosis calls for reduction by either non-operative or operative measures. The former is accomplished by gently squeezing the glans between the thumbs and forefingers (Fig. 55), and drawing it out rather than pressing it inward, while the ring and middle fingers catch the skin back of the constricting band and endeavor to pull it forward. When this fails the size of the glans can sometimes be reduced by wrapping about it a narrow strip of rubber dam in much the same manner as an Esmarch's bandage is applied. When this has been done the handle of a scapel can usually be inserted beneath the constriction, and from behind forward when the foreskin has been rolled back, and the constricting ring can thereby be levered forward over the corona. The successful application of these methods is much facilitated by light anæsthesia.

When nonoperative measures fail or sloughing threatens, reduction must be accomplished by cutting the constricting band, which, when the foreskin has

been rolled back, lies behind an œdematous collar; when the foreskin has been stretched back, lies in the coronary sulcus. A half-inch cut in the middorsal line supplies adequate section of the constricting band, as indicated by easy and complete reduction. The incision may be left to heal by granulation, or it may be sutured at right angles to its long axis. Hot compresses are applicable to cases of threatening or actual sloughing.

FIG. 55.—Reduction of paraphimosis.

Shortness of the Frænum

This congenital or acquired deformity in certain cases interferes with complete erection of the glans, turning the orifice of the meatus downward, and not only preventing ejaculation in the proper direction, but also rendering sexual intercourse painful, or even impossible. Treatment is by division of the frænum, with suture of the resultant gaping wound at right angles to its long axis.

INJURIES OF THE PENIS

CONTUSION.—This implies an injury by crushing force without lesion of the skin. Owing to the looseness of the cellular tissue, ecchymosis and œdema are often so pronounced as to simulate rapid gangrene.

When the vessels of the cavernous bodies are involved there results a circumscribed fluctuating tumor, most prominent during erection. This tumor is somewhat slow in forming, and occasionally suppurates. Under conservative treatment it usually disappears. When injury has not only occasioned extensive extravasation of blood, but has lacerated the urethral canal, the inflammatory phenomena observed after rupture of the urethra quickly develop (see p. 158). Moreover, there is immediately bleeding from the meatus, which should lead to prompt diagnosis and appropriate treatment.

Treatment.—The treatment of contusions of the penis is conducted on general principles—rest, elevation, pressure by narrow gauze bandages, the application of evaporating lotions, and, for the purpose of hastening absorption, gentle massage.

Extensive swelling and discoloration need not occasion anxiety, unless there has been rupture of the spongy or cavernous bodies or of the urethra. When gangrene is threatened on account of the severity of the lesion or because of interference with circulation occasioned by the pressure of effused blood, hot antiseptic fomentations frequently repeated are indicated. These dressings are made by wringing fifteen or twenty layers of aseptic gauze out of a hot 1 to 10,000 bichloride solution. They may be covered with waxed paper to prevent evaporation. If the symptoms are still progressive, free incision and ligation of bleeding vessels, followed by suture of the wound, are indicated. Emphysema is always a serious symptom, and usually calls for free incision, with abundant drainage. It usually indicates a sloughing or gangrenous process.

Wounds of the Penis.—These may be incised, punctured, lacerated, contused, or a combination of these forms.

Incised Wounds, if superficial, are readily closed and heal quickly. Wounds involving the erectile tissue bleed freely, and, if transverse and extensive, are liable to be followed by loss of erectile power in the tissue lying anterior to the wound.

Treatment.—Hemorrhage is checked by ligatures: the cut surfaces are apposed by sutures passed through the fibrous sheath of the erectile tissue, but no deeper.

Inflammatory reaction usually excites erection, which interferes with primary healing, and should be prevented by full doses of bromide (ʒiii daily), by opium and belladonna suppositories, or by hypodermics of morphine. Even if the penis hangs by but a small strip of tissue, bleeding points should be ligated and the fibrous sheath should be restored by suture.

When the penis is completely cut off, the bleeding vessels are tied, the cavernous bodies are covered in by suture of their fibrous envelopes, the skin is drawn forward and sewed over the closed ends of the corpora cavernosa, and the urethra is split, and secured to the skin to prevent subsequent stricturing of its orifice (see p. 138).

When the urethra is divided it should be sutured, and the urine should be drawn by a small, soft catheter. Intermittent catheterization is practised for five days, the instrument at each passing being attached to a fountain syringe and introduced with a stream of protargol (1 to 2000) flowing through it. After the bladder is emptied, the fountain syringe is again attached to the catheter, and as the latter is withdrawn the anterior urethra receives another antiseptic washing. When the introducing of the soft catheter is excessively painful, continuous catheterization should be practised (see p. 73 *et seq.*).

If, as a result of cicatrization following wounds, erection is complete but there is deviation of the penis from a straight line, cure by operation may be successful. When, however, there has been obliteration or obstruction of the spaces of the spongy and cavernous bodies, producing deviations and incomplete erections, treatment is unavailing.

Punctured Wounds of the penis, when inflammatory symptoms are pronounced and infection is probable, should be converted into incised wounds, cleansed, and drained from the bottom.

Contused and Lacerated Wounds of the penis, under which heading would

come gunshot wounds, are particularly dangerous only when the urethra is involved or the injury is so great as extensively to devitalize tissues. When extensive they are liable to be followed by imperfect erection or by distortion of the penis. The treatment consists in subduing inflammatory phenomena and providing for drainage. Bleeding in these cases is moderate; when the urethra is involved permanent catheterization is practised (see p. 73).

Fracture of the Penis.—This injury, possible in a literal sense only when the penis has undergone calcification, occurs when during vigorous erection the organ is subjected to a sudden twist or bend. The cause of the injury is usually a false movement in coitus, though a wrench or a blow will also produce it, as, for instance, when the penis is caught in closing a bureau drawer, or is bruised by a falling window-sash.

Symptoms.—The symptoms of this injury are sudden, severe pain and a sense of something having given way, consequent on a bending or twisting strain of the erect penis. The erection subsides at once, and there is rapid and immediate swelling.

Prognosis.—From the functional standpoint the prognosis must be guarded. When the spongy body and urethra have been involved in the injury extravasation of urine and infection may occur (see p. 160).

Treatment.—Rest in bed, the firm bandaging of the penis in the erect position against the abdomen, the application of evaporating lotions, and, if needful, drawing the water by catheter (see p. 73) usually will be followed by arrest of hemorrhage and gradual absorption of clot.

When the blood effusion forms a large tumor, and particularly when the hemorrhage continues, threatening by tension the vitality of the part, an incision must be made, thus allowing ligature of the bleeding vessels and accurate suture of the torn fibrous sheath. Erections are prevented by keeping the bowels opened and by giving full doses of potassium bromide (℥ii to ℥iv daily).

Dislocation of the Penis.—This accident is produced by traumatism exerted upon the anterior portion of the flaccid organ. The penis is pinched out of its sheath and driven into the scrotum, the loin, or the neighboring regions, much as a grape is squeezed out of its skin. The inner layer of the prepuce, which should prevent this accident, gives way either at the preputial orifice or, more commonly, along the line of the coronary sulcus. The urethra is usually ruptured in the perineal region.

Symptoms.—The symptoms of this accident are not so marked as would be supposed. The skin sheath of the penis is often filled with clotted blood, thus simulating the presence of a shrunken organ. There is usually free hemorrhage from the preputial orifice. Later there is extravasation of urine, with its concomitant symptoms. Careful investigation will always show the absence of the erectile tissues from their proper position and their presence elsewhere.

Treatment.—The treatment consists in immediate replacement of the organ. This usually requires an incision, though in one reported case the penis was hooked forward by an instrument introduced into the preputial orifice. There should be no hesitation in making the required incision so free that the proper manipulations for reduction can be easily carried out. A perineal urethrostomy may be needed to care for the urine.

INFLAMMATORY AFFECTIONS OF THE PENIS

The penis and its envelopes are subject to the inflammations observed in other parts of the body. Aside from the distinctly venereal diseases, eczema, dermatitis (notably that from ivy poisoning), pruritus, urticaria, erythema, intertrigo, the bites of insects, parasitic diseases, herpes, erysipelas, lymphangitis, folliculitis, abscess, diffuse cellular inflammation, and gangrene are to be noted.

Eczema very commonly affects both the scrotum and the penis, and is extremely rebellious to treatment. The exciting cause is often chafing or rubbing of the parts, though a constitutional dyscrasia, such as gout, diabetes, or rheumatism, commonly predisposes to the disease. It usually appears on the prepuce or about the base of the penis.

The treatment is the same as for the disease situated in other parts of the body, except that, as the skin is extremely sensitive, irritating applications must be avoided.

Acute Inflammation of the Penis may be localized or diffuse. It may involve the subcutaneous cellular tissue or the structure of the erectile tissue. Abscess is treated in accordance with general principles, whether it be superficial or placed in the substance of the organ, *i.e.,* it is opened and drained.

Gangrene occasionally results from deep-seated acute inflammation, which may be due to local causes, such as phimosis or paraphimosis, traumatism, or urinary extravasation, or may develop as a result of thrombosis after acute fever, such as typhoid, or may be incident to diabetes. The trophoneurotic gangrene secondary to cord lesions is guarded against by dry cleanliness and the avoidance of pressure.

Treatment.—The treatment of gangrene of the penis is that applicable to this condition in other parts of the body. In case the gangrene is rapidly spreading, removal of the dead tissue by scissors and curette, supplemented by thorough application of the actual cautery, is indicated. Compresses soaked in hot bichloride solution (1 to 10,000) and changed every half-hour are applied till healthy granulations form, when boric ointment, or a dry dusting powder, such as iodoform, or acetanilid, may be substituted.

When gangrene is less fulminant in type, hot compresses, changed every three minutes (bichloride solution 1 to 10,000, at a temperature of 110° F.), may be applied for twenty-four hours, supplemented by thorough spraying of the involved parts with peroxide solution every two hours. When the gangrene is distinctly slow in type and resists ordinary treatment, a long-continued general bath or hip bath is indicated. This should be kept comfortably hot and should be mildly antiseptic (℥ss bichloride, or ℥xii boric acid, to the bath). The genitalia should be kept submerged day and night for days, and even, in exceptional cases, for weeks. Many of these cases of indolent gangrene are late manifestations of tertiary syphilis in persons afflicted with visceral disease.

The systemic treatment is extremely important in all cases of gangrene. This must be tonic and stimulating. Easily digestible food in as full quantity as can be given, tonics, particularly iron, strychnine, and small doses of bichloride (grain one-sixtieth thrice daily), and stimulants are indicated. The bowels

should be moved regularly. Diabetic gangrene should receive appropriate constitutional treatment.

Chronic Inflammation of the Erectile Tissues and its fibrous envelope, particularly of the corpora cavernosa, results in slow, often painless, areas of induration, which may be fibrous, calcareous, or even bony (Fig. 56), and which attract attention only because they prevent complete erection. The cause of these indurations is unknown. They are observed in middle-aged men, and are often associated with the rheumatic and gouty diatheses. They have been regarded as late lesions of syphilis. With this disease they have no relation, though it must be remembered that gummata may appear in the corpora cavernosa.

Symptoms.—Palpation demonstrates one or more circumscribed, hardened, possibly tender areas, varying from the size of a split pea to that of the thumb-nail. The erect penis is bent at the seat of hardening, and often erection is incomplete in the portion of the involved cavernous body lying to the distal side of the lesion.

Treatment.—The treatment of this affection is without avail. In the early stages, when slight constant pain and beginning hardness indicate the nature of the case, pressure by means of a thin rubber bandage, inunctions of mercuric ointment, and the internal administration of potassium iodide and wine of colchicum root, continued for many months, may prevent permanent crippling. When the lesions are fully formed the same treatment may be tried, but with slight prospect of success. When a calcareous or a bony plate materially interferes with functional activity and is placed superficially, there can be no objection to removing it by a cutting operation, but the operator should hold out no definite hope of restoration of function.

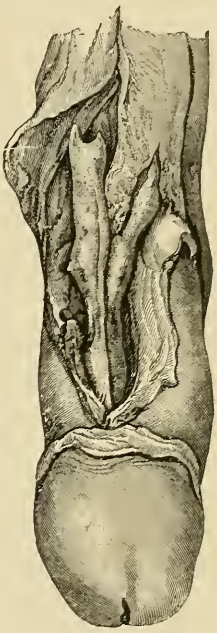


Fig. 56.—Osseous growth of the penis. (Demarquay.)

Lymphangitis is secondary to peripheral inflammation, sometimes nonspecific, but usually of venereal origin.

Symptoms.—The inflammation usually affects the lymphatics of the dorsum of the penis. Beneath the skin can be felt one or more cords, often starting about the region of the frænum and passing upward and backward behind the corona to the dorsum of the penis, along which a distinct cord can be felt extending as far back as the symphysis pubis. This cord is tender, hard, not very sharply circumscribed, and over its course the skin is reddened and sometimes adherent. This line of induration may attain the size of a lead-pencil. It is attended with a great deal of pain, which is especially severe during erection. Exceptionally an indurated knob forms, sometimes just behind the corona in the loose subcutaneous connective tissue, sometimes in the course of the dorsal lymphatics; this slowly enlarges, giving comparatively little pain, softens, and on being opened discharges pus. From this a persistent fistula may result which can be cured only by extirpation.

Phlebitis of the dorsal vein of the penis would not be accompanied by that enlargement of the lymphatic glands of the groin which is rarely absent when

lymphangitis of the penis is observed. Moreover, the vein passes backward in the middle line, and is not deflected towards the groins as is the case with the lymphatic vessels, and is placed more deeply so that it cannot be lifted up with the skin.

Treatment.—Free drainage of pus from the anterior urethra, appropriate treatment directed towards lessening the severity of the urethritis, and careful cleansing of the preputial sac are matters which should receive close attention. Following these, rest should be enjoined, the bowels should be opened, and continuous applications should be made of cloths kept wet with alcohol and lead water equal parts. Hot baths, local or general, are also serviceable, and when the erections become troublesome potassium bromide should be given in sufficient doses to control them. This drug failing, hypodermics of morphine may be given at night to procure rest. When pus forms it should be evacuated by incision, the remaining cavity being curetted.

In a very rare form of lymphangitis the lymphatic vessels of the prepuce are dilated without marked inflammatory phenomena. The symptoms of this affection usually appear after coitus or other cause of acute congestion. On retraction of the prepuce the congested, semitransparent lymph-vessels are easily detected, passing upward and backward from the frænum towards the dorsum of the penis. The swelling subsides in a few days, but recurs after each attempt at coitus, until finally it becomes permanent. When the swollen vessels are unduly prominent, mechanical disturbance is followed by marked symptoms of local inflammation.

The treatment in the early stages consists in prolonged hot local baths and the use of astringents. Fluidextract of hamamelis, one part to four parts of water; ammoniated mercurial ointment, ten grains to the ounce of carbolated cosmoline; ointment of belladonna and mercury, one part to four parts of lanolin, well rubbed in; or compresses kept wet in lead water and laudanum, often effect cures.

When the dilatation becomes permanent surgical interference is necessary. Excision of a portion of the enlarged vessel is followed by a temporary increase of swelling, but ultimately by cure.

Balanitis and Balanoposthitis.—Balanitis is an inflammation of the surface of the glans penis, balanoposthitis is of both this surface and the inner layer of the foreskin.

Causes.—The principal predisposing cause is a redundant or phimotic foreskin. This keeps the apposed surfaces macerated and irritated, favors retention and consequent decomposition of smegma and urine, and offers conditions most propitious to a successful inoculation when specific virus is introduced within the preputial sac. The gouty or rheumatic diathesis and diabetes also predispose to this form of inflammation.

Infection of a predisposed surface, usually by pus organisms, is the exciting cause.

Symptoms.—The symptoms of balanitis in its mildest form, from which most men who are not careful as to local cleansing suffer at times, are a sense of heat and itching about the end of the penis, some redness and swelling near the preputial orifice, a discharge which crusts and is extremely offensive, and on

stripping back the foreskin a hyperæmic infiltrated integument exhibiting on its surface a thick, creamy deposit, and at times patches of superficial excoriation (Fig. 57). In the coronary sulcus is found an abnormal quantity of semi-liquid, offensive smegma.

In severe cases the excoriations are extensive and well marked, inflammatory phenomena are more pronounced, and the whole prepuce becomes greatly swollen, and in consequence phimotic (inflammatory phimosis). The discharge is profuse. This form is often secondary to gonorrhœa, chancroids, syphilitic lesions, or general troubles, such as diabetes. It is, however, not due to the direct action of specific germs of the venereal disease, the gonococcus, for example, but to

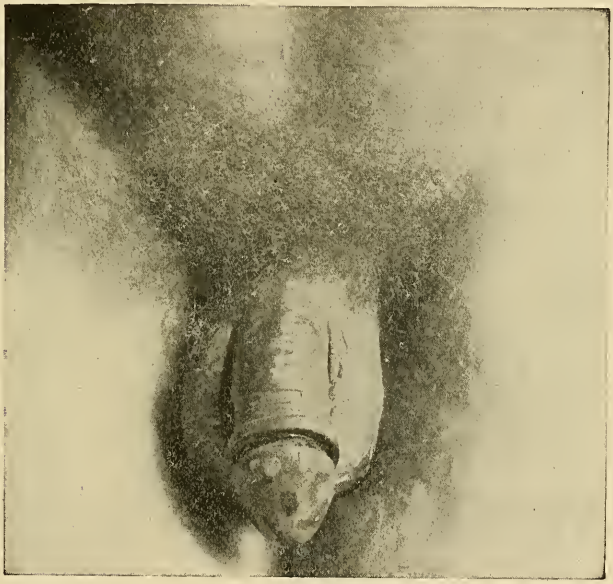


FIG. 57.—Balanitis.

the irritation incident to the contact with decomposing discharges and to infection with the ordinary staphylococci.

In certain cases the erosions and superficial ulcerations start from the corona, exhibit circinate borders, and progressively involve the entire surface of the glans and foreskin, lasting for several weeks, and, so far as extension is concerned, resisting all treatment.

As a consequence of balanoposthitis there may develop: (1) lymphadenitis; (2) condylomata; (3) hypertrophy; (4) gangrene.

Lymphadenitis, at least the suppurative form of the affection, is rare.

Condylomata frequently develop during or after balanoposthitis.

Hypertrophy of the foreskin, in the sense of a greatly elongated, thickened, rigid prepuce, interfering with physiological activity, may result in consequence of organization of the inflammatory infiltration consequent on repeated attacks of acute or subacute inflammation. It is noticed in middle-aged men, especially diabetics. It is sometimes followed by epithelioma.

When the inflammation is hyperacute, inflammatory swelling may be followed by gangrene. This is scarcely possible except in phimotic cases. There is little danger to life in this process, which is self-correcting. There may be, however, ultimate cicatricial deformity.

Diagnosis.—The superficial, irregular, or circinate erosions, together with the surrounding surface hyperæmia and the characteristic discharge, render diagnosis fairly easy when the foreskin can be retracted.

Herpes at first exhibits vesicles, and, when these vesicles have ruptured, circinate lesions. The distinction between these and the erosions of balanoposthitis is not always possible, nor is it important.

Chancroidal balanoposthitis develops insidiously, is characterized by an inflammatory infiltration or thickening or hardening of the glans and foreskin rather than by an acute œdema, exhibits more distinctly circumscribed erosions, which are shortly converted into true ulcers, and is soon followed by characteristic inguinal adenopathy.

Syphilitic balanoposthitis, occurring as a secondary lesion, is diagnosed by the history of the case, the appearance of characteristic lesions on other surfaces of the body, and the development of moist papules primarily, after which neglect of treatment may occasion a general inflammation of the preputial sac.

Only in case of purulent discharge complicated by tight phimosis there is difficulty in deciding between balanoposthitis and chancre, chancroid, and gonorrhœa. In such cases incision of the prepuce is usually indicated to render the lesions accessible for inspection and treatment.

Treatment.—The basis of all treatment is cleanliness. If the prepuce can be retracted, the inflamed surfaces are washed with a mild antiseptic solution, dilute subactetate of lead lotion, or bichloride solution 1 to 4000, dried by means of absorbent cotton, and the erosions brushed with a ten per cent. silver nitrate solution; the parts are then dusted with a powder made of equal parts of bismuth subnitrate and calomel, a very thin layer of absorbent cotton is placed over the glans, and the foreskin is drawn forward. This dressing should be changed several times daily.

When the discharge is profuse, very finely powdered alum or tannin may be used in place of the calomel and bismuth. Lumpy or gritty dusting powders do more harm than good.

When the inflammation is unusually acute and erosions are extensive, a wet dressing is indicated. Under such circumstances, after washing, the dusting powder and silver nitrate are omitted, the thin layer of dry cotton being placed directly on the glans and then wet with the required solution, preferably lead water, or fluidextract of hydrastis canadensis one part, rose water nine parts. In phimotic cases the preputial sac should be washed out every two hours, first with warm water and soap, then with clear water, and then with mild antiseptic solutions, such as sublimate 1 to 4000, or carbolic acid 1 to 500, or, better still, a solution containing both these antiseptics in the proportion just given, by means of a hard-rubber syringe provided with a conical nozzle. The whole preputial sac should be ballooned out with the solution, unless great pain is caused by this distention. Following the antiseptic injection the hydrastic

solution 1 to 10 should be used. When suppuration is very profuse, peroxide of hydrogen may precede the antiseptic injection.

General swelling of the prepuce is combated by keeping the parts wrapped in gauze wet in dilute alcohol and lead water equal parts.

Chancroidal balanoposthitis, or that complicating diabetes, is alone liable to occasion such marked swelling as to require splitting of the foreskin. Good results may be obtained by following the procedure described under " Chancroid " (see p. 126). In diabetic cases, in this region as elsewhere, rigid cleanliness is of especial importance.

Herpes Progenitalis.—This affection is characterized by the rather sudden appearance of vesicles clustering upon erythematous bases, and attended with itching and burning (Fig. 58). Commonly they appear in or about the coronary

Fig. 58—Herpes of the glans.

sulcus, involving both the glans and the foreskin. When thus placed the covering of these vesicles is quickly macerated, leaving rounded or irregular erosions which may become confluent but still exhibit a polycyclic outline. A mild balanoposthitis usually complicates herpes; the affection sometimes causes suppurating buboes. Warts frequently develop.

When these lesions are neglected the abrasions may be converted into punched-out ulcers (ulcerating herpes).

Sometimes the lesions are accompanied by intense pain, much like that of herpes zoster; the affection is then termed neuralgic herpes. The pain may precede the development of the vesicles, which may be so few and discrete as to attract little attention. The burning, shooting pain is generally confined to the penis; occasionally it is reflected to the perineum and the groins, and even down the thighs. This neuralgic herpes is sometimes accompanied by urethral discharge simulating gonorrhœa, but differing from it in the absence of gonococci.

This discharge is not favorably influenced by local or general treatment. Exceptionally there is marked sexual erethism, causing prolonged erections and nocturnal pollutions.

Herpes having once appeared is prone to develop again; at times the recurrence is observed hard upon the first attack, new crops of vesicles forming as fast as earlier lesions are healed. More frequently there is a distinct interval between attacks. When it has this tendency to relapse it is called recurrent, and is often neuralgic in type.

Herpes appearing upon the outer surface of the prepuce does not differ from the eruption as observed on other surfaces of the body. The eruption, wherever it is situated, may be discrete, even to the extent of the formation of but one or two vesicles, or confluent, forming in this case usually small patches, sometimes completely covering large surfaces and causing intensely painful inflammatory erosions.

In women the pain accompanying herpetic eruptions on the genitalia may be of crippling severity.

Etiology.—The causes of herpes are practically the same as those of balanoposthitis. The eruption is predisposed to by rheumatism, gout, and a neurotic tendency; also locally by any causes tending to excite inflammation, such as phimosis and urethral or preputial discharges. The mechanical irritation of immoderate coitus, together with the effect of prolonged contact with any irritating uterine or vaginal discharge, may be an exciting cause. Neuralgic herpes is an expression of local circulatory disturbance due to nerve lesion.

Diagnosis of herpes is founded upon the rather sudden appearance of vesicles in clusters, either without obvious cause or following closely upon mechanical or chemical irritation. When the lesions are observed in their vesicular stage they cannot well be confounded with any other affection. When they are placed on the moist surfaces of the glans and foreskin, however—and this is their usual situation—they are rarely observed before the coverings of the vesicles have been macerated and the lesions are erosive or ulcerative in type. Even then they are usually superficial, multiple, circular, or, when confluent, at least circinate in type, nonindurated, except when placed at or within the urethral orifice, rapid in development, nonprogressive, with moist, red surface; when squeezed they give a slight serous discharge. If kept clean rapid healing ensues, though new lesions may occur on previously healthy surfaces.

The differential diagnosis must be made from chancre, chancroid, balanoposthitis, and mucous patches (see p. 117). The lesions of balanoposthitis are usually more diffuse and rather irregular or serrated than polycyclic in outline. Moreover, they are not preceded by vesicles. The differential diagnosis cannot always be made, since herpes is generally accompanied by more or less balanoposthitis. Mucous patches are accompanied by other manifestations of syphilis, are slower in development than herpes, do not begin as vesicles, and present a grayish necrotic pseudomembrane in place of the red, moist, shining surface of the herpetic lesion.

Treatment.—Cleanliness is the key-note of successful treatment. Antiseptic washings, careful drying, painting with silver nitrate, dusting with zinc oxide or bismuth, the interposition of a thin layer of cotton between the two moist surfaces, and, if necessary, the remainder of the treatment described as appro-

priate to balanoposthitis, ordinarily bring about cure in a few days. When the inflammation is more than usually acute, a wet dressing should be substituted for the dusting powder. In the ulcerating form the system is usually at fault.

Neuralgic herpes is often benefited by painting with silver nitrate solution ten grains to the ounce, or solution of chloral one drachm to the ounce, or carbolic acid lotion 1 to 60; the erosions should then be dressed as already described. This form of herpes is, however, not readily influenced by local treatment, though spraying with four per cent. cocaine solution may relieve the pain, or the following ointment may be applied:

℞
Cocainæ hydrochlor., gr. xii
Menthol, gr. i
Lanolin, ʒiv
M. S.—Use locally.

Hypodermics of morphine are indicated in the more severe cases, they not being required for more than three or four days, particularly if the patient has been subjected to the eliminating treatment appropriate to gout, rheumatism, or other underlying cause of the nerve lesion.

Recurrent herpes is most frequently observed in connection with a redundant or phimotic prepuce or stricture. The cure of these conditions often brings permanent relief. When there seems to be no local predisposing factor, the surfaces most often affected should be frequently bathed in aqueous solutions of hydrastis extract 1 to 5, or hot saturated solution of alum, and after exposure to any form of irritation should be thoroughly cleansed with mild antiseptic lotions, washed with the astringent, carefully dried, and dusted with stearate of zinc or bismuth, or carbolized talc. A general tonic and supporting dietetic and medicinal treatment should be prescribed at the same time, minute doses of arsenic and bichloride of mercury (grain one-sixtieth of each t. i. d.) and the less irritating iron preparations being particularly indicated.

CHANCROID

The chancroid is a contagious venereal ulcer. It has no distinct period of incubation, is inflammatory and destructive in type, and is frequently accompanied by suppurating buboes. It is a local and not a constitutional disease. It has been variously named soft chancre, simple chancre, and noninfecting sore.

Cause.—While multitudes of other bacteria are regularly found in chancroidal sores, the cause of the lesions is a short, thick, slightly dumb-bell-shaped streptobacillus, known as the bacillus of Ducrey. Often present in very small numbers in the original sore, and for this reason difficult to recognize, in the ulcers obtained by experimental inoculation these bacteria are found in much larger numbers, often in pure culture. Ducrey's bacillus is decolorized by Gram's method, is stained readily with the ordinary aniline dyes, and is difficult to cultivate on artificial media.

Inoculability of Chancroid.—Auto- and hetero-inoculation are almost invariably successful when performed with the pus of chancroids of short duration, the

inoculation being accomplished by abrading the skin with the point of a knife and rubbing in a minute quantity of the chancroidal secretion. In from one to four days a pustule appears, which develops into a typical chancroidal ulcer. After repeated inoculations in one region a relative immunity is developed, which does not affect the remainder of the body, and disappears in the course of a few months.

Frequency of Chancroids.—Chancroids are, in hospital practice at least (and especially in Europe), more frequently encountered than chancres, but among the well-to-do the chancre is more frequently seen than is the soft sore.

The Localization of the Chancroid.—The chancroid may be placed upon any cutaneous or exposed mucous surface. It is usually located on or about the genitalia; extragenital chancroid is far less frequent than extragenital chancre.

Genital chancroids in the male are usually found upon the glans and the prepuce (Plate VI). The favorite positions are at or near the frænum, in the

FIG. 59.—Multiple chancroids of the coronary sulcus.

coronary sulcus (Fig. 59), along the margin of the prepuce, on the moist surfaces of the glans and the foreskin, and at the urethral orifice.

In females these lesions are found along the margins of the greater and smaller labia, about the fourchette, and in the region of the urinary meatus (Fig. 60).

Anal chancroid is much more frequent in women than in men. In them it is commonly due to infection of cracks or fissures about the rectal opening by the contagious discharge which flows backward from the vulva. The chancroid is usually multiple.

Pathology of Chancroid.—The chancroidal ulcer is made up of a small, round-celled infiltrate, somewhat sharply limited in depth, but extending considerably beyond the borders of the ulcer, and invading papillæ which are still covered with apparently healthy epithelium. These papillæ undergo marked hypertrophy.

The blood-vessels are dilated and increased in number, and exhibit in the adventitia an inflammatory infiltration. The lymphatic vessels are also abnormally numerous, and open directly into the ulcer.

PLATE VI.

A
Chancroids of the prepuce.

B
Epithelioma of glans.

THE CLINICAL ASPECTS OF CHANCROID

Chancroid as acquired by coitus differs somewhat in its clinical aspects from that caused by intentional inoculation. The pustular stage is rarely observed, the patient not detecting the lesion until an ulcer has developed, since the chancroid is usually so placed that the thin skin covering the pustule is quickly macerated. The acquired chancroid frequently seems to have a period of incubation varying from three to seven days; exceptionally the apparent incubation is much longer; generally this is because the sore is not noticed in its early stages. Ricord explains these cases on the theory that the virus is deposited on healthy surfaces, which subsequently becoming eroded offer an entrance-point to the microörganisms.

FIG. 60.—Chancroid of labium major.

The shape of the chancroid depends upon the shape of the eroded surface through which inoculation takes place, and also upon the anatomical peculiarities of the part. Thus, inoculation of a " hair-cut " is followed by a linear chancroid the inoculation of an extensive abrasion by a sore corresponding in outlines with this abraded surface. The lesions of herpes preserve their general outline, but take on chancroidal ulceration. An infected follicle forms first a hard, rounded, elevated lesion resembling a furuncle. This rapidly breaks down and discharges, exposing a characteristic chancroidal ulcer (Fig. 61). When the chancroid involves the sides of the frænum it forms a long, irregularly shaped lesion, which not infrequently causes complete destruction of this bridle. When it is placed in the coronary sulcus it has a tendency to extend in the direction

of this furrow (Fig. 62). When it attacks the anus it spreads in the direction of the skin-folds of this region.

Symptoms.—(1) There is no period of incubation; (2) the lesions are multiple (Plate VII, Fig. 63); (3) they begin as pustules or ulcers and are rapid in their course; (4) they form ragged, punched-out, often undermined ulcers, irregular in shape, discharging freely, inflammatory in type, and covered with a gray, pus-soaked slough, which may be concealed by a thick, moist scab; (5) they produce similar lesions on surfaces with which they come in contact, and their discharge can be inoculated on any portion of the surface of the body; (6) they are not indurated; (7) scrapings from their surfaces show pus and shreds of necrotic tissue, but no epithelium; (8) they are frequently complicated by inflammatory bubo.

FIG. 61.—Follicular chancroid.

A positive diagnosis cannot be founded on any one of these characteristic features of the sore, but must rather be based upon associated symptoms. While the lesions are often multiple, this is by no means an invariable rule. The characteristic feature in regard to the multiplicity of chancroids is that they generally appear not simultaneously, but *successively—i.e.,* from auto-inoculation; though when several abrasions are inoculated at the same time the multiple lesions will, of course, develop coincidently.

Though the disease usually begins as a pustule or an ulcer, its first manifestation may take the form of a more or less indurated papule, in which acute inflammatory phenomena may progress with comparative slowness. The follicular chancroid sometimes develops in this way. Exceptionally the chancroid appears as a purely superficial lesion, its nature not being suspected until it

PLATE VII.

Multiple chancroids. (Fox.)

assumes typical chancroidal characteristics or causes other chancroids by auto-inoculation.

Sometimes chancroids are indurated; this is particularly true of the follicular chancroid and of those sores which have been cauterized. When the chancroids are seen early and are carefully treated suppurating buboes are the exception rather than the rule.

What might be called the natural auto-inoculation—that is, the production of other and similar sores upon healthy surfaces with which the first lesion comes in contact—is one of the strongest reasons for pronouncing an ulcer chancroidal in nature, since this rarely takes place from other forms of ulceration.

Diagnosis.—Chancroid must be distinguished from *chancre,* from *herpes,* from *follicular abscess,* from *erosions of balanitis* and *balanoposthitis,* from *ulcer-*

FIG. 62.—Exulcerating or superficial chancroid.

ating papular syphilides, from *ulcerating gummata,* and from *tuberculous ulcerations.*

The distinction between the soft sore and the *chancre,* the one which the surgeon most frequently will be called upon to make, is sometimes extremely difficult, and may, indeed, be quite impossible except by finding the typical organisms in the serum exuding from a rubbed or scraped sore which has not been treated by antiseptics. The chancroidal and syphilitic infections may both be present, in which case the rapidly progressive and destructive inflammation of chancroid may completely mask the indurating lesion of chancre. The typical features of each sore, with a diagnostic table, have been set forth in another part of this work (see p. 699), but it is not amiss to call attention here to the fact that the chancroid may be indurated, while the chancre may not be.

In the chronic chancroid attacking the vulva of women, the secondary hardening may be so absolutely like that of the primary lesion of syphilis as to deceive the most skilled. Again, chancroid may cause chronic enlargement of several of the inguinal lymphatic glands, thus departing from its type, while chancre may make a parallel variation by causing suppurative lymphadenitis.

In typical cases a distinction may be readily made, but in those which are atypical in the absence of bacteriological findings the surgeon should not commit himself to a positive opinion.

The lesions of *herpes, follicular abscess,* the erosions of *balanitis* and *balano-posthitis,* or *mechanical abrasions* may readily be mistaken for chancroids when they first appear. In a few days, at most, the superficial nature of the inflam-

FIG. 63.—Phagedænic chancroid.

mation and the prompt yielding to cleansing applications show that chancroidal infection is absent.

Ulcerating papular syphilides when found upon the genitalia closely resemble chancroids, but are slower in their course, are less inflammatory in type, and other lesions of the disease are exhibited; a history of preceding syphilitic infection usually may be elicited, and the spirochæte may be found in the serous exudate of a mucous patch.

Ulcerating gummata of the genitalia produce lesions indistinguishable in appearance from chancroids. Here, again, however, a history of syphilis, the development of a tumor preceding ulceration, the slow progress of the lesion (weeks instead of days), the absence of the symptoms of acute inflammation, and the effect of constitutional treatment lead to a correct diagnosis.

Tuberculous ulcers are extremely rare; they cannot be distinguished from chancroidal lesions by inspection alone. They have, however, a history of very

slow extension (weeks or months), are usually associated with tuberculous lesions in other parts of the body, sometimes exhibit about the periphery of the ulceration grayish, semitransparent, miliary tubercles, and on microscopic examination of the scrapings of the lesion often show the tubercle bacillus. Moreover, inoculation in guinea-pigs will after a time disclose the true nature of the lesion.

Sometimes a differential diagnosis can be made only by auto-inoculation—a valuable means of determining the presence or absence of the chancroidal virus, but one which is not infallible. Its value is perhaps best formulated by stating that the majority of chancroids will produce ulcers of a similar type on auto-inoculation, while the majority of other ulcers, either syphilitic, tuberculous, or inflammatory, will not produce such lesions.

Complications of Chancroid

1. Phimosis and paraphimosis; 2, Excessive inflammation, phagedæna, and gangrene; 3, Lymphangitis and lymphadenitis.

Of all these complications lymphadenitis, or bubo, is by far the most common.

FIG. 64.—Chancroidal phimosis. Secondary chancroids about the preputial orifice.

Phimosis.—This forms a serious complication of chancroid, mainly because it prevents the ulcer from being efficiently treated and causes retention of discharge, and consequently favors the occurrence of acute inflammation and the formation of inguinal buboes (Fig. 64).

In severe cases extensive sloughing and gangrene may occur. The foreskin

becomes dark, almost black, cold, nonresisting, and finally melts down at one or more points into a putrid, pultaceous mass. This gangrenous process may attack also the glans penis, and partly or totally destroy it.

Diagnosis.—The diagnosis of subpreputial chancroid is founded upon the severity of the inflammatory symptoms, upon their persistence, or even their aggravation, in spite of careful treatment, and upon the result of auto-inoculation. At times palpation elicits local tenderness, and the inflammatory induration of the lesion may be recognized by touch through the foreskin.

Paraphimosis.—Patients with congenitally short prepuces, or those whose foreskins are habitually retracted, frequently suffer from paraphimosis incident to the swelling occasioned by chancroid; or this condition may result from retraction of the foreskin after the swelling is well advanced, as it is then often impossible to draw it forward. This complication is much less troublesome than phimosis, since the lesion is exposed and can be properly treated. It occasions, however, more rapid and dangerous congestion than phimosis, and usually demands immediate relief.

Gangrene—Phagedæna.—Chancroids may be unusually inflammatory in type from the first, or after a comparatively mild course may suddenly become acutely inflamed.

The causes of this are usually a *general cachectic condition, local irritation,* and *disturbances of circulation,* as from phimosis and paraphimosis.

In these cases swelling and redness extend far beyond the lesion and the whole part becomes œdematous. The patient complains of pain, there is often a mild inflammatory fever, and the ulcer rapidly spreads.

If the causes producing inflammation remain still operative and prompt treatment is not applied, the lesion becomes *gangrenous;* in this case swelling is more pronounced, and large areas become dusky red, dirty brown, and finally quite black and putrid. In a very few hours extensive tissue-destruction may result. The entire penis may be destroyed, the testicles may be laid bare, and the process may extend far up the belly-walls. The constitutional symptoms are pronounced.

At times the destructive process is much slower in its course, ultimately producing lesions quite as extensive, but rather by molecular death. The ulcer steadily extends, in spite of treatment, until it attains enormous dimensions, exposing the blood-vessels of the groins, destroying the entire scrotum, eating far back along the perineum, and leaving but the stump of the penis. This process is termed *phagedœnic,* and is never observed except in those whose systems are profoundly depressed. Thus it is encountered in diabetics, or in those suffering from scurvy or scrofula, from visceral diseases, such as chronic hepatitis and nephritis, or from tertiary syphilis.

The phagedænic ulcer sometimes lasts for months or years manifesting a tendency to heal in one part while it steadily extends in another, the lines of extension often having a circinate or serpentine outline. This form of ulceration is termed *serpiginous.*

Lymphangitis, or inflammation of the lymphatic vessels, is a rare complication of chancroid, even in the presence of suppurating buboes. Resolution usually takes place under appropriate treatment.

Bubo, or **lymphadenitis** (Fig. 65), as has been stated, is the commonest complication of chancroid. The number of cases suffering from this complication varies, according to different reports, from five per cent. to thirty per cent. of the total number suffering from chancroid. In hospital practice about one out of five ambulant chancroid cases develop bubo; in office practice and among the well-to-do this complication is comparatively rare, on account of earlier treatment. The glands involved are generally those to which the lymph-vessels supplying the seat of ulceration pass most directly—*i.e.*, the group of glands lying below Poupart's ligament, above the saphenous opening. The glands lying near the middle line of the body to the right and left of the symphysis pubis

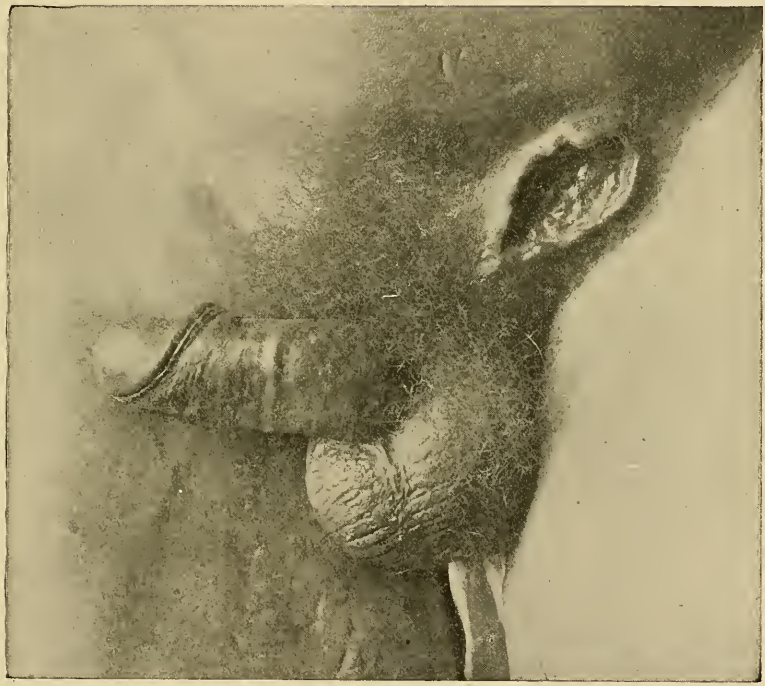


FIG. 65.—Chancroidal bubo.

generally escape. Adenitis from lesions of the foot or leg attacks primarily the glands lying just below the saphenous opening in the course of the long saphenous vein.

It is usual, in cases of sores on the genitalia, for bubo to form on the side of the body corresponding with that of the lesion, but this rule is at times reversed. Lesions of the frænum frequently cause bilateral buboes and, indeed, sores of this region and upon the prepuce and glans are followed by a larger percentage of buboes than when the chancroids are located on any other part of the genitalia.

Cause.—Aside from the fact that retained discharges distinctly predispose to bubo, the character of the sore seems to have little influence in the develop-

ment of this complication. Thus a sloughing or gangrenous chancroid will run its course without any effect upon the lymphatic glands, while a superficial lesion the size of a split pea may be accompanied by a double suppurating lymphadenitis.

This complication usually develops from the second to the fourth week of the chancroid. It may, however, appear almost as soon as the lesion, or may develop weeks after the chancroid has been completely cicatrized.

The *direct cause* of bubo is not clearly formulated. It has not been demonstrated that the destructive adenitis is invariably due to the action of microörganisms upon the gland. Cultures and auto-inoculations made with the discharge of buboes give negative results, and microscopic examination of such discharge may fail to show bacteria. The degeneration of the glands is probably partly owing to the presence of a chemical irritant absorbed from the ulcerating surface.

Symptoms.—The bubo usually begins with a sense of pain on motion referred to the inguinal region. On examination there is found a hard, tender lump over which the skin is freely movable. This lump steadily increases in size, becomes constantly painful, and is so tender that the patient is confined to his chair or bed. The overlying skin becomes reddened, adherent, and œdematous. The patient complains of rigors, fever, and thirst, and finally on examination fluctuation is detected.

The pain may be constant and severe; sometimes without obvious cause it is suddenly relieved. This is due to rupture of the gland capsule and escape of its contents into the surrounding tissue, and is followed by rapid increase of swelling and breaking down of the periglandular tissues.

On evacuation of the suppurating bubo, thick, blood-stained pus is discharged, leaving a cavity with gray and necrotic walls. On digital examination of this cavity it is often possible to detect several swollen glands which have been involved in the inflammatory process but have not yet been completely destroyed. These are felt projecting into the space from which the pus has been evacuated.

Usually, after evacuation of the pus and proper surgical treatment of the resulting cavity, healing takes place promptly. In such cases the lesion is said to be a *simple bubo*. Exceptionally soon after opening the bubo its whole surface becomes converted into a huge ulcer corresponding in type with chancroid. This is termed the *chancroidal bubo* (Fig. 65). Appropriate treatment, however, shortly converts this into a simple ulcer, which ultimately heals kindly, though, as in the case of the chancroid itself, inflammation, gangrene, or phagedæna may complicate the healing. It is probable that the bubo is never primarily chancroidal, but becomes so by inoculation either during or after operation.

In women buboes rarely complicate chancroids. When they occur they are generally found in the inguinal region, the lymphatic vessels about the vulva and the rectum communicating with the glands of the groin.

Prognosis.—The chancroid as it occurs in healthy people, and especially in those who are cleanly in their habits and who scrupulously follow a mild antiseptic treatment, runs its course in from three to six weeks without complication. Even if no treatment whatever is applied, the majority of chancroids heal spon-

taneously in six weeks. During the whole course of the lesion, and even after cicatrization has taken place, buboes may form, and prognosis as to the avoidance of this complication should be extremely guarded. Except in the most superficial forms, the lesion is followed by scarring.

Treatment of Chancroid

Since it is pretty generally conceded that chancroid is due to inoculation with the discharge of a similar lesion, and since such inoculation takes place almost invariably by sexual congress, the prophylaxis of chancroid is comparatively simple. Where, however, this means (*i.e.*, avoidance of exposure) is not adopted, the external genitalia should be thoroughly washed with soap and water and then smeared with 33 per cent. calomel ointment, the ointment being allowed to remain on the parts for several hours.

Whatever form of treatment is adopted, the end to be attained is the conversion of the unhealthy spreading ulcer into a healing, granulating surface. Since the virulent properties of the chancroid are dependent upon the presence of microörganisms, it necessarily follows that efficient treatment must have for its end either an inhibitory or a destructive action upon these microörganisms, or must so increase the local resistance that the lesion cannot spread. Antiseptics in some form are indicated. These should be either so mild that they produce little or no irritation, or so powerful that they cause total destruction of the entire diseased area, *i.e.*, they should be distinctly cauterant.

Under the application of mild antiseptics the chancroid is usually cured in from two to six weeks. Under the application of cauterants a cure sometimes results in from seven to fourteen days.

Satisfactory results may be obtained by the observance of surgical cleanliness, not only of the surface of the sore, but also of the surrounding skin or mucous membrane. After thorough washing with soap and hot water, a spray of hydrogen peroxide, full strength, is directed on the chancroid and the skin near it; this is followed by washing or spraying with carbolic 1 to 60 or bicholoride 1 to 3000.

After the chancroid and the surrounding surfaces have been cleansed, the surgeon may conduct the treatment with either non-irritating antiseptic applications or with cauterants.

Non-irritating antiseptic applications may be made in the form of powders, of ointments, or of lotions.

Dry Dressings.—The powders commonly employed are iodoform, aristol, iodol, boric acid, calomel, acetanilid, zinc stearate, zinc oxide, and bismuth subnitrate. None of these are strongly antiseptic. The most efficient is iodoform; this has practically no antiseptic value, but in the presence of pus undergoes decomposition, the products of which have a distinct inhibitory effect upon further germ-growth. The objections to the use of the drug are its penetrating odor and occasionally the production of violent inflammation. The odor may be in part disguised by mixing with the powder, in the proportion of a drop to a drachm, oil of lavender or attar of roses, or finely pulverized coffee in the proportion of one part to five may be added to the iodoform. None of these expedients will be found perfectly satisfactory.

In applying this powder it is important to bring it directly in contact with the ulcerating surface; when it is placed upon the surrounding skin or upon crusts covering lesions it is absolutely useless. It can be dusted upon the lesion by means of a small pledget of cotton which is first rubbed in the powder, or by an insufflator, or in the form of a spray of iodoform in ether. It should be used only after the lesion has been thoroughly cleansed by hydrogen peroxide and dilute antiseptics.

Iodol and aristol have similar properties, but are more prone to form crusts, thus favoring retention of discharge. In clinical practice they have been found distinctly less efficient than iodoform.

Argyrol in substance applied after cleansing the chancroid, secured by bandage and redressed daily, has resulted in many cures.

Zinc, calomel, and bismuth are mainly efficient as drying agents, though they undoubtedly have feeble astringent and antiseptic properties.

Dusting powders should never be allowed to form with the secretions scabs or crusts, thus preventing the escape of discharges, and they should be brought immediately in contact with granulating surfaces. Boric acid and salicylic acid are sometimes useful as dusting powders, and are less prone thus to form crusts than the insoluble preparations. Salicylic acid is often so irritating that its application is not advisable.

If dry dressings are used, the lesion is treated from one to six times a day in accordance with the amount of discharge. It is first cleansed, then dried by means of absorbent cotton, then dusted with the remedy of choice; finally a thin sheet of absorbent cotton is laid over it, and is retained in position by straps or bandages, or by pulling the foreskin forward.

Dry dressing is indicated in chancroids of moderate severity which are not inflammatory in type and which do not discharge profusely.

Wet Dressings.—In place of the dusting powders, after thorough cleansing of the lesions and surrounding parts there may be placed on the ulcerating surface pledgets of cotton wet in one of a variety of mild antiseptic lotions. Of these the most efficient are Wright's solution (sodium chloride, 4 per cent.; sodium citrate, 1 per cent.); carbolic acid, 1 to 60; bichloride, 1 to 3000; phénol sodique, 1 to 6; and lead water. These wet cotton pledgets should be changed frequently, especially when the discharge is abundant. This is readily managed, since the patient can carry with him a small bottle of the antiseptic solution and some cotton. He should change the cotton pledget each time he urinates. The dressing is kept in place by the foreskin in many cases, or by straps, bandages, jock-straps, or swimming-tights.

The wet dressing is especially indicated in patients whose inclination or surroundings prevent them from carrying out the cleansing required in dry dressings, and in patients whose lesions discharge freely and are inflammatory in type.

Antiseptic Ointments.—Ointments used in treating chancroids have for their active principle a drug such as iodoform, boric acid, salicylic acid, carbolic acid, or one of a large variety of similar antiseptics. They are most useful when there is a tendency to form crusts, and when the lesions are cicatrizing.

Cauterization.—Immediate and complete destruction of a chancroidal ulcer is the safest routine treatment, since thus its virulent qualities are immediately

destroyed and there results a healthy granulating surface which quickly cicatrizes, and which, if kept clean, is attacked only in very exceptional circumstances by the complications characteristic of chancroid. The main objection urged against this method of treatment is that it is unnecessarily severe, since the majority of chancroids will heal kindly under simple antiseptic dressings. This argument obtains particularly among the well-to-do, who, by careful observance of treatment, usually recover promptly. In dispensary patients, however, and in those who are careless, or who, from their surroundings, cannot treat chancroids in accordance with the principles of surgical cleanliness, cauterization is particularly to be commended.

For cauterizing chancroids, nitric acid, sulphuric acid, caustic potash, bromine, iodine, zinc chloride, copper sulphate, arsenious acid, and the actual cautery have all been successfully employed.

The best instrument for destroying chancroids is the actual cautery; this may be used in the form of a heated iron, Paquelin's cautery, or the galvano-cautery.

In performing the operation the chancroid and the surrounding healthy area are first thoroughly cleansed, and are then anæsthetized by means of a hypodermic injection of a one-half per cent. solution of novocaine driven into the cellular tissue wide at the base of the lesion. The cautery at a white heat is then applied, so that not only the chancroid is destroyed, but also the surrounding tissue to the extent of one-eighth of an inch from the borders of the sore. The cautery must be carried to every recess of the ulcer. If sinuses are present, these must be slit up and their unhealthy walls cauterized. If the minutest portion of the sore is left untouched by the cautery, the probability is that the entire lesion produced by the operation will again become infected. After cauterizing, the surrounding parts should again be thoroughly disinfected. The dry eschar resulting from the burning is dusted with iodoform and protected by the application of a little absorbent cotton. In from three to five days this eschar comes away, exposing a healthy ulcer, which quickly cicatrizes.

Inflammatory swelling resulting from this application is combated by the application of strips of gauze wrung out of lead water, or lead water and alcohol equal parts, and kept constantly wet with this solution.

In case the actual cautery cannot be employed, nitric acid should usually be selected. It should be applied to the anæsthetized sore by means of a bare wood applicator, every part being thoroughly and deeply cauterized. The after-treatment is the same as after the use of the actual cautery. Caustic potash, iodine, and other cauterants are employed in the same way.

Cauterization is indicated when chancroids are seen in their early stages, when they are rapidly extending, and when they are gangrenous, phagedænic, or serpiginous.

Cauterization is contra-indicated when the inflammatory swelling incident to its use would probably occasion phimosis or paraphimosis, when the chancroid is markedly inflamed but not yet sloughing extensively, and when the lesion has passed through its virulent stage and is healing.

High-frequency Vacuum Electrode.—This is doubtless the most efficient treatment for chancroids. The sore is cleansed, dried, anæsthetized with a solution of cocain, painted with a 25 per cent. solution of copper sulphate and

thoroughly sparked with the high-frequency electric current, employing the vacuum electrode. One treatment usually suffices to sterilize completely the sore, which is followed by healthy granulation and prompt healing.

Operation.—Two operations have been suggested and carried out in the hope of accomplishing the immediate cure of chancroid.

The first consists in a thorough curetting of the lesion, careful antiseptic washing, and dusting with iodoform powder. The second in excision of the lesion and immediate suture of the resulting wound.

If reports of cases could be accepted as conclusive evidence in favor of any treatment, these operations should be universally adopted. Our experience, however, has not corroborated the favorable opinion of these methods advanced by others.

Treatment of the Complications of Chancroid.—*Phimosis.*—When the subpreputial chancroid is complicated by phimosis, efficient treatment is rendered difficult by the fact that the sore is not readily accessible and by the retention of discharge; consequently such lesions are prone to become inflammatory in

FIG. 66.—Phimosis caused by chancroid of the meatus, treated by lateral incisions (one week after operation). Note the relative exposure of the glans obtained by this method and by a single dorsal incision (FIG. 67), both wounds having become infected.

type, to excite œdema and congestion, to develop phagedænic or gangrenous symptoms, and to be complicated by buboes. When the symptoms of inflammation are moderately severe, satisfactory results may be obtained by the frequent employment of mild antiseptic subpreputial washes and the external application of evaporating lotions. Thus the whole preputial sac may be syringed out every two hours with hydrogen peroxide, followed by mild bichloride solution (1 to 6000), or other unirritating antiseptic. The penis should be kept elevated, so that venous congestion may be diminished, and should be wrapped in gauze kept wet with alcohol and lead water, equal parts of each; or, when the circumstances of the patient are such as to permit this treatment, subpreputial washes, followed by prolonged soaking of the penis in water, or 4 per cent.

sodium chloride solution, as hot as can be borne, are at times most efficacious in reducing inflammation. The soaking should last for an hour, and should be repeated three or four times daily.

If, despite this treatment, swelling rapidly increases, and it is evident that the chancroid is steadily extending, exposure should be secured by means of an incision in each side of the prepuce (Fig. 66). A general anæsthetic may be given for the operation, or local anæsthesia as described for circumcision may be used. The operation is performed with a pair of scissors, one blade of which is slipped along a grooved director to the bottom of the preputial sac, and then thrust through both layers of the foreskin; the incision is then made

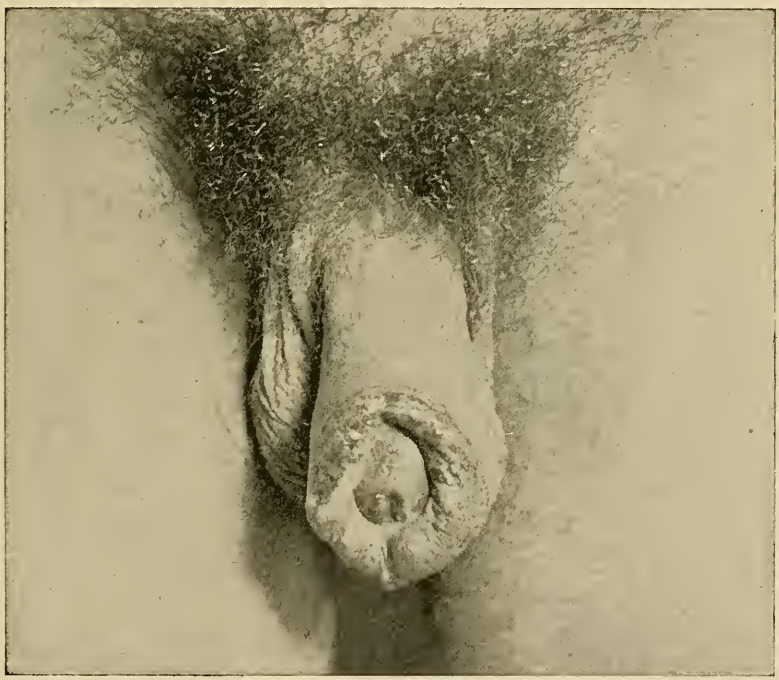


FIG. 67.—Chancroidal ulceration of an incision of the prepuce required for the relief of phimosis.

with one cut, after which the operation is repeated on the opposite side. The inner and outer cut margins of the prepuce should be united by sutures to limit the size of the granulating area. The two incisions are preferable to a single dorsal (Fig. 67) on account of the better exposure of the region of the frænum afforded by this method. When a particularly virulent strain of organisms is obviously present it is advisable to sear the cut surfaces with the cautery, or better still to make the incisions with a cautery knife. Circumcision is to be performed after healing is complete.

The objection to performing circumcision at this time lies in the fact that the operation wound is usually converted into a chancroid. Moreover, when there is great œdema, there is difficulty in accurately gauging the flaps. These

objections are not of sufficient weight to cause circumcision to be rejected invariably; indeed, in a fair proportion of cases, when every antiseptic precaution has been taken, union may be almost as prompt as when nonchancroidal lesions are subject to operation. There can, however, be no certainty that the circumcision wound will remain healthy.

Gangrene and Phagedæna.—When gangrene develops, the first indications are to relieve constriction or pressure. When it complicates a phimosis or a paraphimosis, these conditions should receive prompt surgical treatment. The patient must be kept in bed, with the involved parts elevated and wrapped in hot antiseptic fomentations frequently changed. These may be made by wringing out pads formed of twenty or thirty layers of gauze wet in bichloride solution (1 to 4000), or 4 per cent. sodium chloride, as hot as can be borne, enveloping the gangrenous regions in these pads, and covering this dressing with oiled silk to prevent evaporation. These compresses should be changed every fifteen minutes. Prolonged soaking of the parts in hot water or a hot mild antiseptic solution is a powerful means of arresting gangrene.

If, in spite of treatment by heat, the gangrene is rapidly extending, the parts already devitalized should be clipped away, and the ulcerated and raw surfaces should receive a thorough application of the actual cautery, or of nitric acid, the field of operation being subsequently dressed with compresses kept wet with lead water and alcohol.

In all cases of gangrene the constitutional treatment should receive careful attention and should be supporting and stimulating. Iron, quinine, and nux vomica are the tonics of choice. Potassio-ferric tartrate has been particularly recommended. Cod-liver oil will be found beneficial in perhaps the majority of cases.

The chronic phagedænic chancroid and the serpiginous sore are so invariably associated with constitutional dyscrasia that local treatment alone is powerless to effect a cure. Often the underlying lesion is syphilitic in nature and appropriate specific treatment will be followed by cure. Frequently it is tuberculous or is dependent upon visceral lesions. In any case general treatment is of cardinal importance. This should be tonic and supporting in type. Stimulants, cod-liver oil, the hypophosphites, and arsenic render valuable service. Locally the lesion should be treated in accordance with the condition of the granulating surface; thus, applications of silver nitrate ten per cent., or copper sulphate of equal strength, followed by dusting with iodoform, will sometimes be followed by good results. Usually these and other mild methods of treatment are perfectly futile. In such cases cauterization of the entire lesion, followed by packing with iodoform gauze and the application of an antiseptic dressing, may accomplish a cure. In some instances a continuous warm bath, lasting for days or even weeks has caused lesions to heal which had resisted every other form of treatment. Occasionally such cases recover when complete change of air and surroundings is made, supplemented by ordinary clean dressings.

Autogenous bacterins are sometimes of great value. McDonagh recommends enormous doses of potassium iodide as being almost a specific.

Lymphangitis.—This comparatively rare complication of chancroid is treated in accordance with general surgical principles.

Lymphadenitis or Bubo.—This complication of chancroid is usually avoided when the lesion is kept thoroughly clean and well drained from the first and when the patient remains quiet. Even when the nodes have begun to swell, as evidenced by pain and tenderness in the groin and the detection of a distinct lump, further enlargement can often be prevented by rest in bed, the administration of a saline purge, and the application over the affected region of heat and pressure. This is best applied by means of lint wet with lead water. Over this is laid the ordinary rubber hot-water bag, the patient lying on his back in bed. Scrupulous attention must be paid at the same time to the cleansing of the chancroid.

When this treatment by rest in bed and application of heat is not practicable, there may be placed over the sore the following ointment:

℞ Ung. hydrargyri,
Ung. iodi comp.,
Ung. belladonnæ,
Ung. petrolei carbolat., āā ʒii.

Over this is placed a compress, and firm pressure is made by means of a spica bandage.

After twenty-four hours of this treatment, if there is no improvement, and particularly if the pain, swelling, and inflammatory phenomena are more marked, time and suffering will be saved the patient by administering ether, and then proceeding at once to excise the affected node or nodes, since it is almost certain in these cases that suppuration will take place. All enlarged nodes are shelled out, and the wound is thoroughly cleaned, and is closed without drainage. When patients object to this radical treatment,—and this will be in the majority of cases,—an effort should be made to cause resolution by the injection of antiseptic solutions into the substance of the inflamed gland. The drug most employed is benzoate of mercury in one per cent. solution. From ten to fifteen drops of this are driven directly into the inflammatory focus. Antiseptic compresses and a pressure bandage are then applied over the affected region. In place of the benzoate of mercury a three per cent. solution of carbolic acid may be employed, ten to twenty minims being injected. After the injections there is a temporary increase in the amount of swelling.

If suppuration occurs in spite of this treatment, or, when a case first comes under observation, if there is fluctuation, the abscess-sac should be punctured under antiseptic precautions, its contents squeezed out, and ten per cent. iodoform glycerin emulsion injected under moderate tension. The cavity should be emptied and refilled twice; as much as will remain of the third filling should be left in, and over the seat of abscess-formation should be placed a large absorbent antiseptic dressing. If, following this operation, there is reaccumulation of fluid in the abscess-cavity, it should again be evacuated by puncture and injected with the iodoform emulsion. If more than two punctures are required, the cavities should be freely incised, gently curetted, packed with sterile iodoform gauze, and dressed antiseptically.

If when the case comes under observation there is a large abscess with the overlying skin livid and devitalized, or already ulcerated through, the cavity should be opened by a free incision parallel to Poupart's ligament. Careful

search should be made for glands beginning to soften but not yet completely broken down, which should be removed either by means of blunt dissection with the finger, or by careful cutting with the knife. The whole wound cavity should be thoroughly curetted, and should be packed with sterile iodoform gauze. Any sinuses which may form must be followed to their end, being freely slit open to the surface. This operation sometimes results in an enormous wound, but no hesitation should be felt in making it, since otherwise ultimate cure is uncertain.

When that form of inflammation is encountered which is sometimes seen in tuberculous cases (that is, when node after node enlarges and slowly breaks down, its capsule becoming firmly adherent to the surrounding parts and the whole forming a large lobulated tumor) removal by careful dissection is the only means of treatment which will be followed by cure. In these cases the nodes sometimes contract adhesions to the femoral vein, and a number of deaths have been recorded from the wounding of this vessel in the course of an operation. Following the dissection the wound is packed with iodoform gauze.

When the bubo has ruptured before it has come under observation, and when it is infected with the ordinary pyogenic microbes, in addition to free incision and curetting it is well to paint the whole raw surface with a solution of tincture of iodin, subsequently packing with iodoform and dressing the wound as before described.

When a bubo becomes chancroidal in type, the resultant sore should be treated in accordance with the principles governing the treatment of chancroid. Thorough cauterization will usually be followed by prompt cure. If cauterants cannot be employed, applications of the ordinary antiseptics are often efficacious.

The treatment of chancroidal buboes may be summarized as follows: (1) Buboes are to be avoided by thorough frequent cleansing of the chancroids and by rest upon the part of the patient. (2) They may be aborted in their earliest stages by active purgation, by rest in bed, and by the application of heat and pressure. If in twenty-four hours abortive treatment is not followed by improvement, no further effort should be made in this direction. (3) If the bubo is steadily progressing in spite of appropriate treatment, excision before softening has occurred offers the quickest method of cure. (4) When this is not practicable, injections of antiseptics into the substance of the diseased glands, followed by pressure and rest, often bring about resolution. (5) When softening has occurred, but the skin is not yet involved, evacuation of the contents of the abscess through a small puncture, followed by iodoform injection or antiseptic irrigation and the application of a pressure bandage, favor resolution. (6) If after this treatment once repeated the abscess-cavity again fills, or if the abscess is large and the skin is already partly devitalized, the abscess should be opened by free incision parallel with Poupart's ligament, all enlarged nodes should be shelled out or excised, all sinuses should be followed to their extreme limit and opened freely, and the ulcerating wound should be packed with iodoform gauze. (7) This same treatment should be applied to buboes which have already opened spontaneously, and should be supplemented by the application of tincture of iodin to the curetted surfaces. (8) The tuberculous type of bubo requires excision of all the enlarged nodes. (9) All operations on chancroidal buboes should be conducted with scrupulous regard to the principles of asepsis.

TUMORS OF THE PENIS

Tumors of the penis may be cystic or solid, benign or malignant.

Under the *benign tumors* are included the cysts (sebaceous, blood, and mucous), papilloma, horny growths, angioma, fibrolipoma, and adenoma. Except papilloma, these lesions are rare.

The *malignant tumors* include carcinoma and sarcoma, the former being by far the commoner. Carcinoma and sarcoma are sometimes observed in infants.

Cysts, fibroma, angioma, etc., are so rarely observed, and when seen coincide so completely with similar growths of other parts of the body, that they require no detailed mention. Sebaceous cysts are occasionally seen in the prepuce. Cysts from distention of Tyson's glands may be multiple, and sometimes reach large size. Angiomata have caused troublesome bladder reflexes.

The *treatment* is the same as that appropriate to like conditions in other parts of the body, *i.e.*, removal when they are increasing in size or cause pain or interfere with function.

Lymphangioma, or elephantiasis, rarely involves the penis alone; usually the scrotum is implicated (Fig. 68). When secondary to inflammation or removal of the inguinal glands it may be self-limited and transitory. Operation may be required (see p. 295). The filaria sanguinis hominis may or may not be found. The diagnosis is nearly always rendered easy by a history of preceding inguinal adenitis or by the associated thickening of the skin of the scrotum and lower extremities. When the foreskin is primarily attacked, at least in the early stages, it may be difficult, and at times even impossible, to decide whether the overgrowth is due to infiltration consequent upon a chronic balanoposthitis, or to elephantiasis. The steady progress of the infiltration, in spite of local cleanliness, in a short time leads to a correct diagnosis.

FIG. 68.—Elephantiasis arabum. (Operated by Professor Neill, University of Pennsylvania.) (From Mutter Museum, College of Physicians. Dec. 19, 1874.)

Verrucæ or Papillomata.—Venereal warts appear as small or large, discrete or confluent, moist or dry papillary overgrowths, usually springing from the coronary sulcus, the posterior border of the glans penis, the inner surface and

margin of the prepuce, the region of the frænum, or the orifice of the urethra (Fig. 69).

Pathologically these outgrowths are found to be due to hypertrophy of the papillary and mucous layers of the skin. At the same time there is a corresponding development of blood-vessels. On the protected surfaces they are moist, from maceration of the epithelial covering; on the skin surfaces, as the penis, scrotum, or thigh, they are generally dry.

The cause of venereal warts can usually be traced to irritation incident to prolonged contact with inflammatory discharges. Thus, in the uncleanly, in those suffering from gonorrhœa, herpes, chancroid, or balanoposthitis, papillary outgrowths are by no means uncommon. The most important predisposing cause is a redundant or phimotic foreskin. In addition there seems to be in certain persons a constitutional predisposition towards papillary outgrowths. Proof as to the contagious nature of discharges from venereal warts is still wanting, though there are many recorded cases of condylomata developing apparently as the result of contagion.

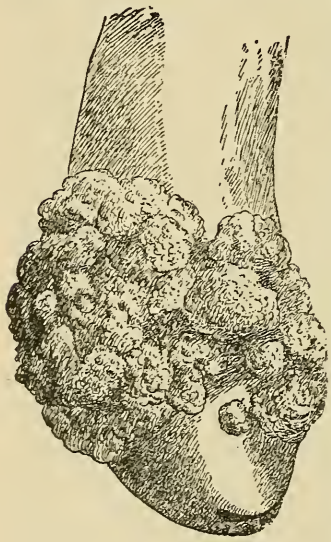


Fig. 69.—Venereal warts.

Symptoms.—Condylomata are found most often in men between the fifteenth and the twenty-fifth year, and in those who give a history of inflammation about the genitalia, either from disease or from redundant foreskin. They appear as markedly vascular outgrowths from either the skin or the mucous membrane. Sometimes they project like one or more threads, or may form discrete, small-sized, tuberous excrescences, or by confluence may produce an outgrowth resembling a raspberry or a cauliflower. The confluent warts often assume the shape into which they are moulded by the pressure of the surrounding parts; thus, under the prepuce, pressed beneath the foreskin and the glans, they may be flat and broad like a cock's comb.

Diagnosis.—Venereal warts may be confounded with the mucous patch or condyloma lata, and with epithelioma.

The condyloma lata or mucous patch rarely appears as an isolated lesion of syphilis; the concomitant signs of the disease and a history of the case usually indicate the nature of the affection, though it must not be forgotten that syphilis may excite true papillary overgrowth almost identical in appearance with the overgrowth of condyloma acuminata.

Epithelioma usually occurs after middle life. It *ulcerates,* grows rapidly, involves the surrounding tissues in a dense infiltrate, and is accompanied by a characteristic induration of the inguinal nodes.

A wart found upon the sexual organs of an old person, even if characteristic in appearance, should always excite suspicion, since this benign neoplasm is comparatively rare after middle life, while malignant growths are by no means uncommon, and in their early period closely resemble the venereal wart. At the

time the differential diagnosis is most important, *i.e.,* in the beginning, it is most difficult. It should be remembered that even at this period of the disease the malignant growth infiltrates the tissues from which it springs. Only by means of microscopic examination of sections from the outgrowth can a positive opinion be given, since clinical experience shows that the benign neoplasm is at times transformed into a malignant growth.

Prognosis.—Venereal warts. if kept clean, and protected from mechanical irritation, spontaneously disappear, though predictions as to when this result will occur can never be made with safety. If utterly neglected, they ulcerate and suppurate, and may often be complicated by inflammatory buboes or by sloughing and gangrene. Exceptionally they form the starting point of cancer.

Treatment.—Complete removal of the papilloma constitutes the only reliable treatment. Where the outgrowths are discrete and small, each is seized in a pair of rat-tooth forceps, drawn upward, and removed, together with the tissues of its base, by a snip of the scissors after having had injected beneath its base a drop of a one per cent. solution of eucaine. If the warts spring from the glans, the little bleeding points left by this cutting are touched with pure carbolic acid, and the dressing is completed by dusting with iodoform or other powder, and, if necessary, applying a clean narrow gauze pressure bandage. The wound left by snipping warts from the prepuce is at once closed by suture without cauterization. When the neoplasm has a large base, the whole outgrowth may be shaved off level with the surrounding surface by means of a sharp, flat knife. The wound left by this incision should be thoroughly curetted, and then should be cauterized with carbolic or nitric acid and dressed with iodoform or with a powder made of calomel and zinc oxide, equal parts of each. General anæsthesia is required for this operation. Only spouting vessels should be ligated, the free primary oozing being readily controlled by the application of adrenalin chloride solution (1 to 1000).

At the time this operation is performed an effort should be made to remove the exciting cause of the lesion. Thus, phimotic patients should be circumcised, urethral discharges should be prevented from coming in contact with the external parts, etc.

When operation is refused, warts may be removed by nitric acid. The surrounding surfaces should be protected by the application of cosmoline; the acid is well rubbed into the wart and a boric ointment dressing is applied. The application is repeated every second or third day until the papillary layer of the skin is destroyed at the point of outgrowth.

Chromic acid is an excellent application, but is open to the objection that occasionally it gives rise to general toxic symptoms. Fatal cases have been reported. It is usually employed either pure or in a ten per cent. solution, brushed over the outgrowth once daily.

Certain non-cauterant remedies are advised, and at times give good results, possibly because of the spontaneous tendency towards healing exhibited by the condylomata. Among these may be mentioned the following:

℞
Acidi salicylici, ʒi
Acidi acetici, fʒi
M. S.—Apply with a brush once daily.

The effect of irritants not strong enough to act as cauterants is to stimulate the papillary outgrowths.

High-frequency desiccation or fulguration by the Oudin current is an efficient method for the destruction of these papillomata, a single treatment sometimes being sufficient for the complete removal of the condylomata. Before the application of the spark, the warts should be treated for ten minutes with a fledget of cotton saturated with ten per cent. cocaine solution.

Horny Growths of the Penis.—In the few reported cases of this affection the growth has sprung from the surface of the glans penis of old men. It is an extremely rare manifestation of perverted epidermic hypertrophy. It is easily recognized, and its main pathological importance lies in the fact that it is at times the forerunner of cancer. The appropriate treatment is the thorough removal of the horn, together with the base from which it grows. When the patient is advanced in years and there is no indication of epitheliomatous degeneration, surgical operation is not indicated.

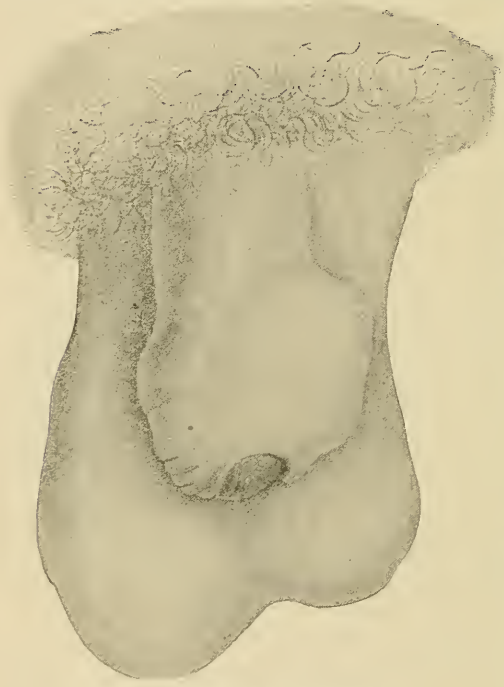


Fig. 70.—Epithelioma. (Demarquay.)

Malignant Disease. — With the exception of epithelioma, malignant disease of the penis is extremely rare.

A few cases of medullary cancer have been described. These develop about the period of puberty, and are apt to be consequent on trauma. They form rapidly growing, lobulated, painful tumors. The lobules may be so soft as to suggest the formation of a cyst. They are usually the phenomena of subacute inflammation, and the lymphatic nodes of the groin are quickly involved. Amputation carried wide of the disease is the only treatment, and even if this procedure be adopted early, the ultimate outlook is extremely unfavorable. Epithelioma or cancer commonly appears on either the glans or the prepuce. It may assume the superficial or the infiltrating form (Fig. 70). It usually develops after middle age, and sometimes grows from the seat of a former chancre.

Symptoms.—Epithelioma generally appears first in the form of a wart, which becomes excoriated, ulcerated, and shortly indurated. The disease, beginning as a small ulcerative vegetation, gradually extends until a large portion of the prepuce and glans is involved (Plate VI, B, and Fig. 71). The ulceration has a hard base and is irregularly excavated. Together with the deep ulcers there

FIG. 71.—Epithelioma, ulcerating form.

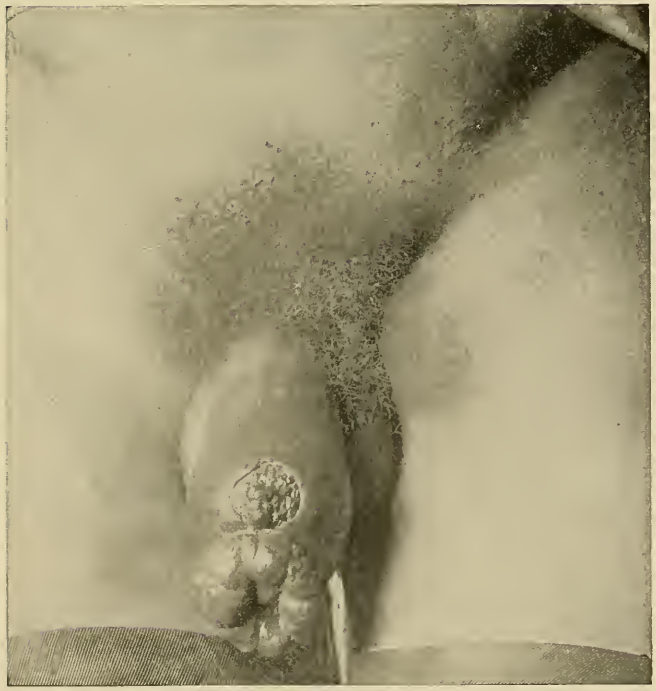


FIG. 72.—Epithelioma, vegetating form.

are often cauliflower-like outgrowths (Figs. 72 and 73). The surrounding skin is infiltrated, œdematous, nodular, elevated, and purplish in color. The glans is greatly swollen, irregular in outline, and lobulated.

As the disease extends backward the cavernous bodies become indurated and the overlying skin, at first slightly adherent, is involved in the disease.

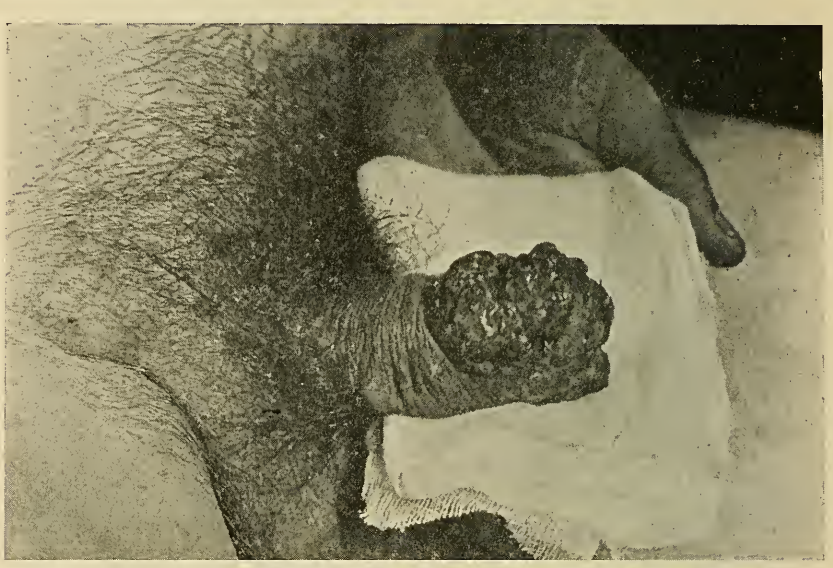


FIG. 73.—Carcinoma of penis, with early lymphatic involvement. (No recurrence 8 years after operation.)

FIG. 74.—Epithelioma with glandular involvement.

Finally the lymphatic nodes of the groin become infiltrated and ulcerated, and discharge fetid, blood-stained pus (Fig. 74).

Etiology.—The presence of a redundant or phimotic foreskin, accumulations of smegma, subpreputial calculi, chronic balanoposthitis, specific or nonspecific ulcerations, indeed, any source of local irritation, may act as a predisposing cause for the development of epithelioma.

Diagnosis.—This is difficult only in the early stages of the disease.

When without obvious cause a warty growth develops on the glans or the foreskin in a person past middle life, this lesion should be carefully watched. Induration about the base (Fig. 75) or ulceration of the excrescence would justify the diagnosis of epithelioma, and would indicate a prompt removal.

Syphilis of the penis may be mistaken for epithelioma, but may be recognized by the characteristics described under this subject.

Prognosis.—The prognosis of epithelioma is grave unless operation is undertaken in its very earliest stages. The course of the affection varies greatly in different cases. Some patients perish in two months, others survive for many years. When the inguinal nodes are involved there is but slight chance of ultimate recovery.

Treatment.—The only treatment to be considered in these cases is entire removal of the diseased part. When the disease has not developed further than

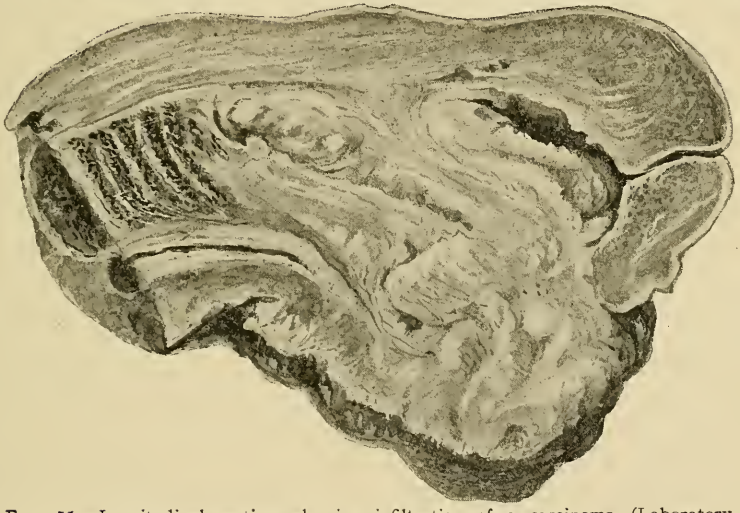


FIG. 75.—Longitudinal section, showing infiltration of a carcinoma. (Laboratory of Surgical Pathology, University of Pennsylvania.)

slight ulceration of an indurated papule, total excision of the involved area, with subsequent cauterization of the excision wound by means of caustic potash, may suffice.

When epithelioma is fairly developed, amputation carried wide of the disease is the only resource. The inguinal lymphatic nodes should be removed at the same time, even though not enlarged.

Partial Amputation of the Penis.—This operation is indicated when the ulceration or infiltration lies an inch or more in front of the penoscrotal junction. The ulcerating mass having been cauterized with pure carbolic acid and occluded by a dressing wet in 1 to 1000 corrosive chloride, and the inguinal regions having been thoroughly cleansed as for any surgical operation, an incision is carried from the middle of Poupart's ligament to the dorsum of the penis, thence down the middle of this organ to the seat of amputation. The superficial layer of fat containing the nodes is then dissected up from each inguinal region and is stripped inward, including the lymphatic vessels of the penis. This mass of tissue, made up of two wings, is carried downward and the Y-shaped incision is

closed by suture. Two inches or more behind the epithelioma a stout acupressure needle is thrust through the corpora cavernosa from side to side, and behind this a medium-sized drainage-tube is wound two or three times around the penis and kept in place by catch forceps or by knotting. By a circular sweep of the knife the skin of the penis is divided at the proposed seat of amputation, which should be at least one inch behind the farthest backward extension of the malignant infiltration. Half an inch in front of this the spongy body of the urethra is cut across and dissected back to the level of the skin incision. The corpora cavernosa are then cut through on a level with the first incision, the rubber-ligature is removed, the bleeding vessels are secured by means of fine-pointed hæmostatic forceps and by catgut ligatures, and the acupressure pin is taken out. Sutures are then passed, drawing together the cut edges of the fibrous sheaths of the cavernous bodies, thus completely covering in the vascular erectile tissue, and both protecting it from subsequent infiltration and infection by the urine and immediately checking oozing. The urethra is split on its floor back to the level of the surface of the divided cavernous bodies. The borders of this incision, together with the divided urethral end, are sutured to the skin. The latter is then stitched so as to cover in the cavernous bodies. The line of suture is dusted with iodoform and is dressed with iodoform gauze. The dressing is held in place by a T-bandage. Continuous catheterization may be employed; it is better, however, to let the patient micturate when desire prompts, removing the dressing to allow of this and irrigating the wound immediately afterwards with corrosive chloride solution (1 to 4000).

Recurrence in the stump after partial amputation is rare, death usually resulting from lymphatic involvement. During the operation, with the help of a freezing microtome, the cross-section should be carefully examined for evidences of malignant infiltration, which if found would indicate a more complete removal. The stump following the partial operation enables the patient to urinate normally and at times to satisfactorily accomplish the sexual act.

Extirpation of the Entire Penis.—This procedure is indicated when the disease is so far advanced that partial excision can no longer be considered. Treves describes the operation as follows:

The patient is placed in the lithotomy position, and the skin of the scrotum is incised along the whole length of the raphe. With the finger and the handle of the scalpel the halves of the scrotum are separated down to the corpus spongiosum. A full-sized metal catheter is passed as far as the triangular ligament, and a knife is inserted transversely between the corpora cavernosa and the corpus spongiosum. The catheter is withdrawn, the urethra is cut across, and its deep end is detached from the penis back to the triangular ligament. An incision is made around the root of the penis continuous with that in the median line. The suspensory ligament is divided and the penis is separated, except at the attachment to the crus. The knife is then laid aside, and with a stout periosteal elevator or rugine each crus is detached from the pubic arch. The two arteries of the corpora cavernosa and the two dorsal arteries require ligature. The urethra and corpus spongiosum are split up for about half an inch, and the edges of the cut are stitched to the back part of the incision in the scrotum. The scrotal incision is closed by sutures, and if drainage is used the tube is so placed in the deep part of the wound that its end can be brought out in front and behind. A catheter is usually retained in the urethra.

CHAPTER IX

SURGERY OF THE URETHRA

(Except Urethritis and Stricture)

THE ANATOMY OF THE URETHRA

The urethra, serving the double purpose of a carrier for the urine and for the semen, is a tubular passage about eight inches in length, of somewhat changing calibre in various parts of its course. Originating from the bladder, it passes through the upper part of the central portion of the prostate gland, pierces the anterior and posterior layers of the triangular ligament about one inch below the lower border of the pubic symphysis, and then, surrounded by the corpus spongiosum, passes on through the penis to the meatus (Fig. 76).

The prostatic portion of the urethra is about an inch and a quarter long, and is the widest and most dilatable part of the canal; the membranous portion is about three-quarters of an inch long, and is the narrowest, least dilatable part of the urethra, except the meatus. The spongy or penile portion of the canal is about six inches in length.

The meatus is the narrowest part of the urethra. Immediately behind this opening the passage widens somewhat, forming the fossa navicularis. Passing backward, the urethra becomes slightly narrower, and, exhibiting a nearly uniform diameter, traverses the spongy body till it reaches the bulb, or posterior portion of this body, where it again dilates. This dilatation narrows abruptly at the anterior layer of the triangular ligament, the membranous urethra being of small but uniform calibre. After passing through the posterior layer of the triangular ligament the urethra again widens out, reaching its greatest diameter at the position of the caput gallinaginis. Before passing into the bladder there is a slight narrowing, noticeable only when the latter viscus is empty.

There are, then, three regions of physiological dilatation. These are located in the prostate gland, at the bulb, and behind the meatus. The natural positions of physiological narrowing are at the meatus and the membranous portion of the canal.

The mucous membrane is continuous with the bladder internally and with the integument of the glans penis externally. It is prolonged into the ducts of all the glands which open into the urethra. The epithelial lining is flat and laminated near the meatus; in other portions of the tube it is columnar.

The submucous tissue is made up of fibrous and elastic tissue, together with unstriped muscular fibres. These latter are arranged in two layers, one passing longitudinally, the other circularly. This muscular layer is most marked in the prostatic and membranous portions of the urethra; passing forward, it becomes thinner, till in the anterior part of the spongy urethra it is replaced in a great measure by fibrous tissue.

On the mucous membrane of the urethra may be seen the openings of many glands and follicles. These are situated in the submucous tissue. The

glands, called the glands of Littre, vary greatly in size, and are most abundant in the spongy portion of the canal and about the meatus. Their orifices are directed forward. The largest of the follicles, called the lacuna magna, is situated in the upper wall of the fossa navicularis, and is one and one-half inches from the meatus.

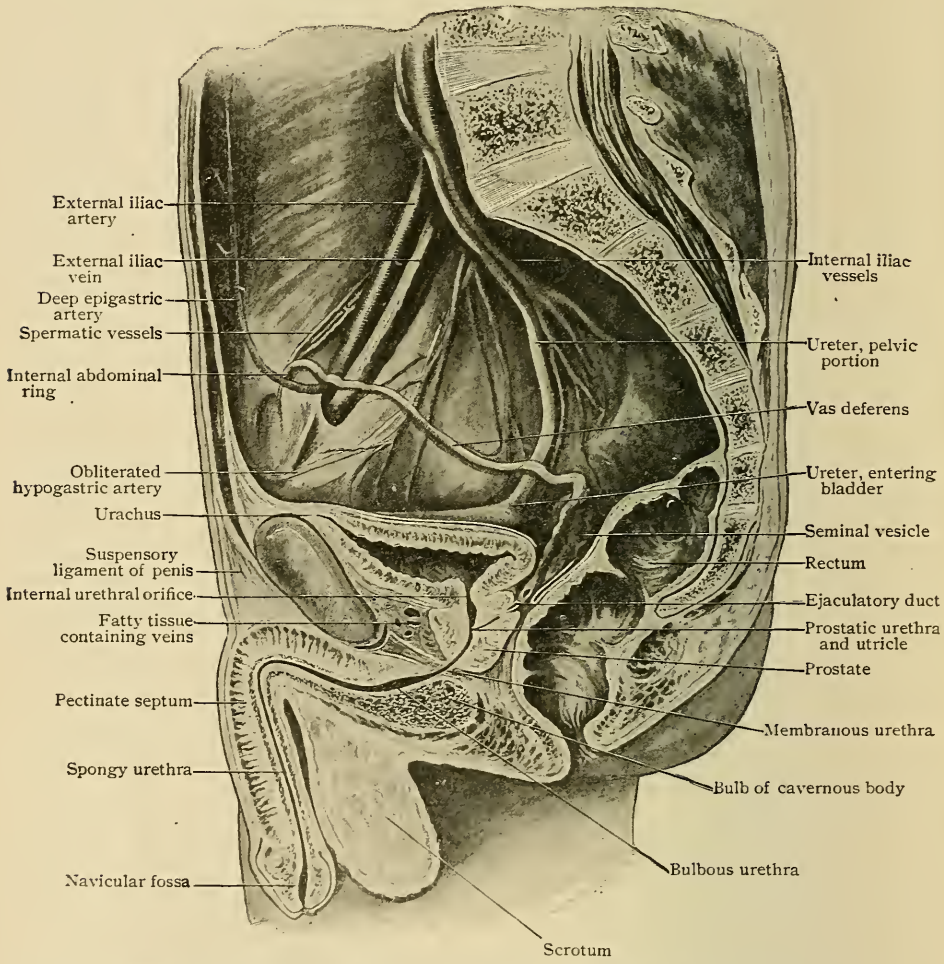


FIG. 76.—Dissection of sagittally cut pelvis, showing relations of organs after fixation by formalin injection. (Piersol's Anatomy.)

The spongy portion of the urethra, so named because it is surrounded by the erectile tissue of the corpus spongiosum, extends from the meatus to the anterior layer of the triangular ligament. It is further subdivided into a pendulous and a bulbous portion. The pendulous portion extends from the meatus to the dilatation enclosed by the bulb (about four and one-half inches in length). The bulbous portion or dilatation (about an inch to an inch and a half long)

is abundantly supplied with mucous glands and follicles; into it also pass the ducts of Cowper's glands. In direction the spongy urethra first passes upward, then curves downward.

The membranous portion of the urethra, beginning at the prostate gland and

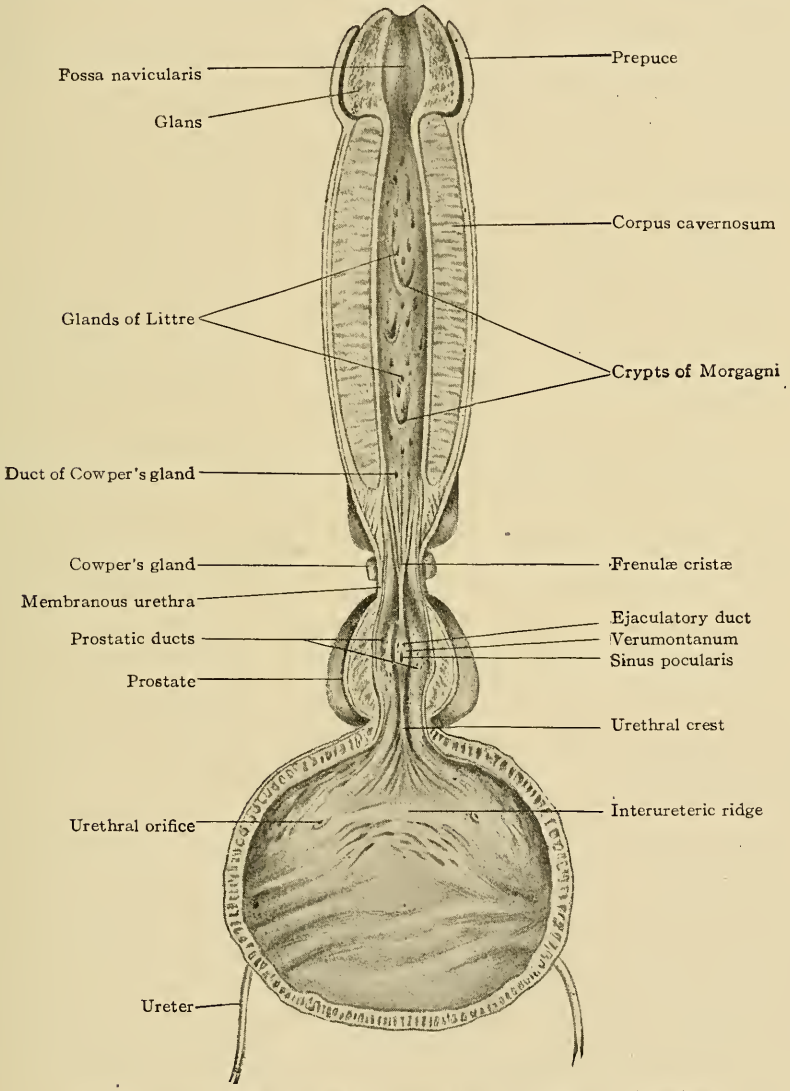


FIG. 77.—Diagrammatic view of horizontal section of bladder and urethra.

ending at the bulb, is separated from the pubic symphysis by muscular fibre and by the dorsal vessels and nerves of the penis; below it lie Cowper's glands. Its upper surface is concave, and is about one-quarter of an inch longer than the lower surface. The perineum separates the lower surface of the mem-

branous urethra from the rectum. In this portion of the urethra the erectile tissue is but slightly developed; in place of it there is a complicated investment of muscular fibres. First there is a layer of unstriped fibres passing circularly and longitudinally. External to this there is an investment of voluntary muscular fibres completely surrounding the urethra. This muscular sheath is named the compressor urethræ.

The prostatic urethra is spindle-shaped,—that is, it is widest at its middle. On the floor of the canal the mucous membrane is projected in the form of a longitudinal ridge, called the verumontanum, or caput gallinaginis (Fig. 77). On each side of this ridge lies a depression, called the prostatic sinus, into which open the orifices of the prostatic ducts. At the summit of the verumontanum is the sinus pocularis, a blind pouch running upward and backward beneath the middle portion of the prostate gland. At or just within the margin of the sinus pocularis are the slit-like openings of the ejaculatory ducts.

At the point where the prostatic urethra enters the bladder it is surrounded by a muscle made up of unstriped fibres, called the internal vesical sphincter; anterior to this a double layer of unstriped muscular fibres and the glandular structure of the prostate surround the urethra. At the apex of the prostate there is a sphincter made up of both voluntary and involuntary muscular fibres, called the external vesical sphincter; it is more powerful than the internal sphincter. Urine is retained in the bladder by the tonic contraction of the muscular apparatus of the membranous and the prostatic urethra (see p. 14).

The compressor urethræ muscle is readily excited to reflex spasm. Ordinarily, on the passage of instruments, a moderate degree of resistance can be detected, due to the contraction of this muscle. In irritable conditions of the mucous membrane there may be excited a spasm so violent that it will be impossible to introduce a soft instrument. Such a spasm may also be excited by irritation of the prostatic urethra, either from distention of the bladder or from any other cause. Thus, it is often found extremely difficult to evacuate the bladder when the desire to urinate has been resisted for many hours; and acute inflammation of the posterior urethra not infrequently requires the use of catheters to overcome the tight muscular contraction of the compressor urethræ which prevents micturition. Not only the introduction of sounds, but even the injection of bland liquids, may cause contraction of the compressor urethræ muscle, and hence prevent such injection from reaching the membranous or the prostatic urethra. Any inflammation in these portions of the urethra may also cause the tonic contraction of the sphincter muscles to be accentuated. Because of the greater power of the external sphincter, accentuated in diseased conditions by this tendency to spasmodic contraction, pus formed in the posterior urethra tends to flow back into the bladder, not forward to the meatus, while secretions formed in the anterior urethra never make their way backward past this point.

There seem, then, to be good grounds, both from a physiological and from a clinical standpoint, for dividing the urethra into an anterior erectile part and a posterior muscular part.

MALFORMATIONS OF THE URETHRA

The urethra may be absent, obliterated, congenitally strictured, sacculated, or deficient as to its floor or its roof. Of these anomalies deficiency of the floor and of the roof, entitled hypospadia and epispadia, are most common.

Absence of the urethra is a malformation usually fatal to the child before birth, since the distended bladder by pressing on the umbilical arteries interferes with the fœtal circulation. Exceptionally the child is born alive with a greatly dilated bladder, in which case the urine may escape through a patent urachus, or by way of the rectum or perineum, fistulæ being formed; or operation by suprapubic or perineal puncture may give relief.

Treatment.—The proper treatment for absent urethra would be the formation of a perineal fistula, the position of the base of the bladder previously having been determined by digital examination through the rectum.

Atresia or obstruction of the urethra, usually at one point, may occur at any portion of the canal, but is commonly observed at or near the meatus. The occlusion may be caused by a thin, easily pierced membrane, the variety ordinarily seen near the meatus or in some portion of the anterior urethra; or the urethra itself may be converted into a fibrous cord, a form rarely observed, except in or near the membranous portion of the canal. In these cases fistulæ often form, giving spontaneous relief. Frequently, however, there is retention of urine, with all its disastrous effects upon the bladder and kidneys and upon the system at large. As in the case of absent urethra, the condition usually causes the death of the fœtus.

The diagnosis is founded upon the failure of the child to urinate, and the presence of a distended bladder.

Treatment.—The treatment, when the obstruction is at or near the meatus, consists in opening the obstructed portion of the urethra by means of a trocar and cannula, a tenotome, or a small sound. When it is placed deeper it would seem advisable to pass a sound down to its anterior face and make an attempt by gentle pressure exerted in the proper direction to pass through it. Having succeeded in introducing an instrument and evacuating the urine (not all at one sitting, in case of great bladder distention), the sound is passed through the seat of obstruction at intervals of three days for several weeks.

When instruments cannot be introduced, the membranous and prostatic portions of the urethra should be opened by external perineal urethrotomy, and the posterior limit of the obstruction determined by passing an instrument from behind forward; or if the occlusion extends well back into the membranous urethra the same result may be accomplished more readily by performing suprapubic cystotomy. The position and the extent of the urethral obstruction having been exactly determined by one instrument passed from the meatus backward, and by another passed from the membranous urethra or the bladder forward, the urethra may be rendered pervious either by instruments cutting from within, a long knife passed through an endoscopic tube, for instance, or by an external urethrotomy, followed by plastic operation. Unless the obstruction be limited to a thin membrane, external operation will be required. An attempt may be made to repair the defect in the urethral lining by transplanting

mucous membrane from the cheek. This is held in place by a few catgut sutures and the permanent catheter, the skin opening being closed by suture. The catheter is left in place six days. Regular dilatation is necessary in the after-treatment.

Congenital strictures, if the usual narrowing at or just behind the meatus be excepted, are extremely rare. If present, they are denoted by slow dribbling urination, with increased frequency, dilatation of the bladder, and colicky pains. Such strictures should be treated by gradual dilatation; this failing, urethrotomy is indicated.

Very exceptionally narrowing of the meatus becomes so extreme that the act of micturition is seriously interfered with. There is usually an associated phimosis, which hides the real seat of obstruction. Meatotomy should be performed immediately, the meatus being kept patulous by the regular passage of bougies till healing is complete.

Valvular folds have been found post-mortem in the prostatic urethra, with characteristic changes of bladder, ureters, and kidneys, showing that they had occasioned fatal obstruction. Such folds are also found about the junction of the penile and the glandular urethra.

The diagnosis is difficult, and is founded on slow, difficult, frequent urination, bladder distention, and colicky pains associated with a urethra which readily admits a small sound.

The urethroscopic tube (No. 12 to 14 F.) might render possible both a diagnosis and treatment by cutting in the case of prostatic valves. The bulbous bougies should find anterior valves; these are readily divided by a tenotome.

Urethral pouches or diverticula may sometimes reach large size. They develop from the floor of the urethra, and in the cases described were found just behind the glans. They were not associated with stricture, but seemed to be dependent for their formation on absence of the erectile tissue, leaving a thin urethral wall which gradually dilated. These congenital pouches are associated with incontinence of urine. They become distended with each act of micturition, and there is subsequent dribbling from the slow leakage of the urine contained.

Diagnosis.—A diagnosis is readily made from the distention observed during the act of urination and from the absence of inflammatory reaction.

Treatment.—The treatment consists in removal of the redundant walls of the pouch and suture of mucous membrane and skin so that the calibre of the resulting urethra at the point of operation shall be about normal.

As an unusual anomaly the urethra, on inspecting the glans, seems to be double or multiple. Exploration of these openings will show one or more blind pouches, the urethra opening by a single orifice. Or in case there is a second channel passing parallel with the urethra, this may be a continuation of the ejaculatory ducts.

HYPOSPADIA

This defect depends upon a congenital deficiency of the floor of the urethra, which channel, instead of being continued to the glandular meatus, opens at some point on the lower surface of the penis. The deformity is fairly common,

being counted by Bouisson once in three hundred males. Duplay describes two chief forms of hypospadia: (1) that in which the urethra is absent in front of the abnormal opening, this being the common form, and (2) that in which the urethra exists in front of the opening, an extremely rare form.

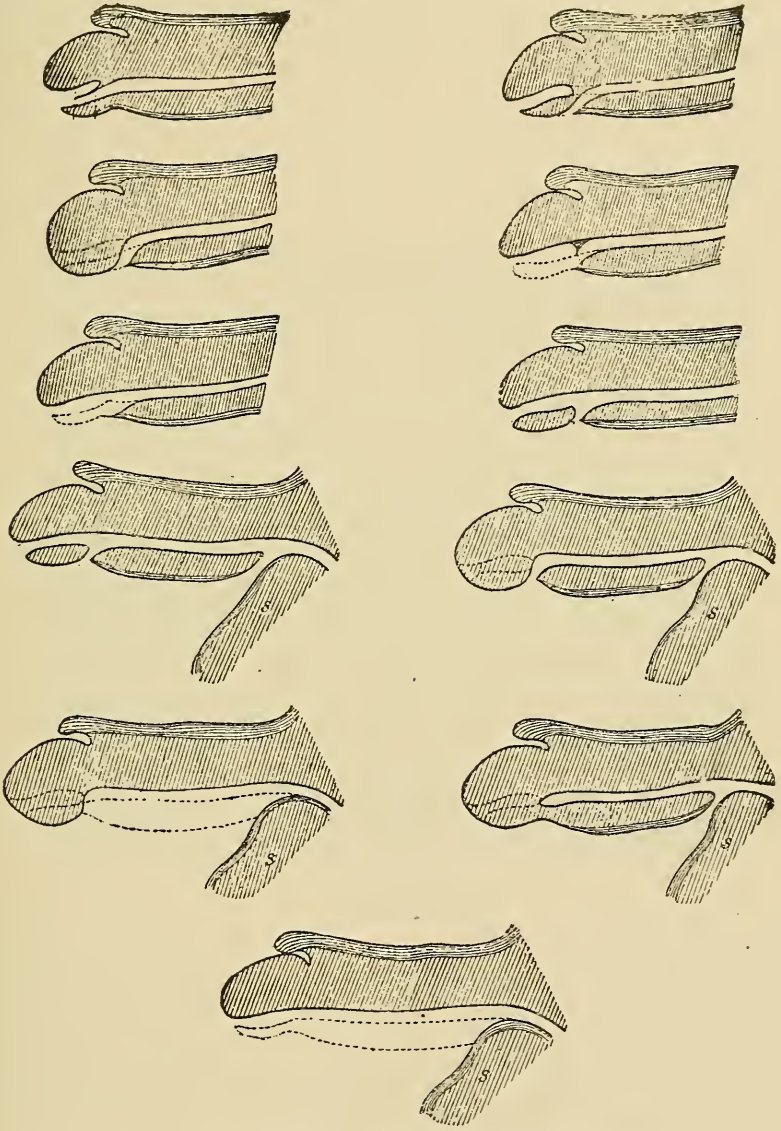


FIG. 78.—Forms of penile hypospadia. *S*, scrotum. (Kaufmann.)

In regard to the position of the opening, hypospadia is classed (see Fig. 78) as (1) balanic, or glandular, the urethra terminating at the base of the glans; (2) penile, the urethra terminating at a point between the glans and the peno-

scrotal junction; (3) perineal, including under this heading the perineo-scrotal forms, where the urethra terminates in the scrotal cleft.

Cause.—The cause of hypospadia is obviously an arrest of development. The prostatic and membranous portions of the urethra, the penile portion, and the glandular portion are each developed separately. The anterior urethra represents, in the early part of its development, simply a groove, which as the fœtus grows is closed from behind forward. Failure to close any portion of this groove, or failure of any of the three separately formed portions of the urethra to unite, occasions hypospadia. Kaufmann attributes hypospadia to obstruction of the urethra persisting after urine has been secreted by the kidneys, in consequence of retention the urethra rupturing behind the seat of obstruction.

Balanic or glandular hypospadia is characterized by a rather broad glans,

FIG. 79.—Peno-scrotal hypospadia.

curved somewhat downward, and covered on its dorsal surface by a thickened hood, the malformed prepuce. The frænum is absent, and the urethra terminates usually in a very small opening at the base of the glans, being continued forward by a narrow groove, representing the upper wall of the navicular fossa. A normally placed meatus is often found, but this is simply a blind pouch. The cavernous bodies are well formed. Other deformities occasionally complicate balanic hypospadia; thus, the penis may be twisted, the cavernous bodies may be stunted or absent, the testicles may be undescended, or the penis may be adherent.

Penile Hypospadia.—The penis in these cases (Fig. 79) is often curved downward, the cavernous bodies are sometimes poorly developed, and nearly always the prepuce is redundant. Associated deformities are more frequently

encountered in this class of cases when hypospadic openings are placed at or near the penoscrotal angle. Rarely the meatus and some portion of the urethra back of this may be preserved, terminating in a blind pouch; or the urethra may continue anterior to the hypospadic opening, ending in a cul-de-sac before it reaches the meatus; or the urethra may be continuous to the meatus, hypospadia then simply representing congenital fistula. The scrotum is not cleft in penile hypospadia.

Perineal hypospadia represents the form characteristic of the most marked interference with development. The scrotum is divided by a deep cleft into two lateral halves (Fig. 80), in each of which there may be placed a normal testicle, though usually these organs are only partially developed, and frequently

FIG. 80.—Hypospadia resembling hermaphroditism. (From Mütter Museum, College of Physicians.)

have not descended. In this case the scrotal flaps closely resemble the labia majora. The penis is stunted, except in its glandular portion, and is curved downward and backward towards the scrotal cleft. On raising it there is seen a funnel-shaped depression, in the deepest part of which the urethra opens by a vertical slit, provided at either side with a muco-cutaneous fold, suggesting the arrangement of the labia minora. These folds pass forward along the under surface of the penis and the glans, constituting either a groove or a ridge, representing the absent urethra. The glans is broadened and incurved, mainly owing to imperfect development of the lower portion of the cavernous bodies; here the fibrous envelope is extremely thick, and the septum between the two corpora cavernosa in some cases participates in the contraction.

Glandular and penile hypospadia do not necessarily interfere with either micturition or the procreative function. By lifting the glans the urine may be projected in an almost normal direction, and, unless incurvation is more than usually marked, sexual congress is possible, but fecundation is doubtful. In the scrotal and perineal varieties the functions of both micturition and copulation are materially interfered with. The backward curve of the urethra obstructs the stream, which is driven out with some force; the urine is usually sprayed

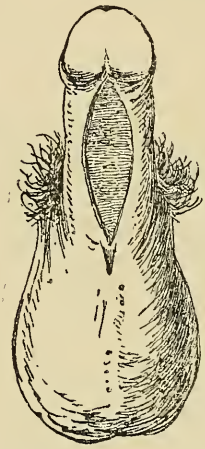


FIG. 81.—Penis straightened after transverse cut of lower surface.

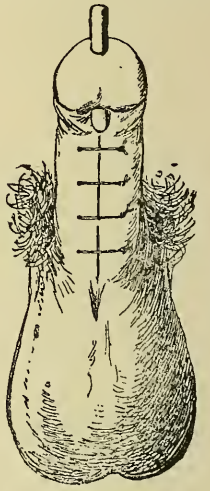


FIG. 82.—Transverse wound sutured longitudinally; glandular urethra formed.

in all directions, requiring the patient to micturate in the sitting position if he wishes to avoid soiling his clothing. On erection the incurvation of the organ becomes even more marked than before; thus copulation is impossible.

DIAGNOSIS.—The diagnosis is made by inspection.

Under some circumstances the determination of sex is extremely difficult in cases of perineal hypospadia. Careful examination through the rectum com-

FIG. 83.—Freshened areas and incisions made in forming glandular urethra.

Glandular urethra closed by sutures.

bined with abdominal palpation will in some cases show the presence of either a prostate or a rudimentary uterus.

PROGNOSIS.—The prognosis of hypospadia, from both a functional and a cosmetic standpoint, is fairly good when the testicles have descended and are normal in size.

TREATMENT.—This consists in the correction of incurvation of the penis where this exists, and the prolongation of the urethra to the end of the penis. This can be accomplished only by a series of operations, three being the usual

number; more are frequently required. Flooding with urine materially interferes with the success of plastic operations. This may be avoided by making a perineal fistula at the time the incurvation is overcome.

The first stage, straightening the penis, is accomplished by a transverse incision across its under surface, dividing the fibrous cord which so frequently passes from the hypospadic opening to the glans, the thickened, contracted sheath covering in the surface of the cavernous bodies, and also, if necessary, a portion of the septum between these two bodies. The incision may be carried as deep as is necessary for complete straightening of the curve; this often implies section into the substance of the cavernous bodies. When the penis has been straightened the wound is united by means of sutures, so that its long axis is at right angles to the line of the original incision (Figs. 81 and 82).

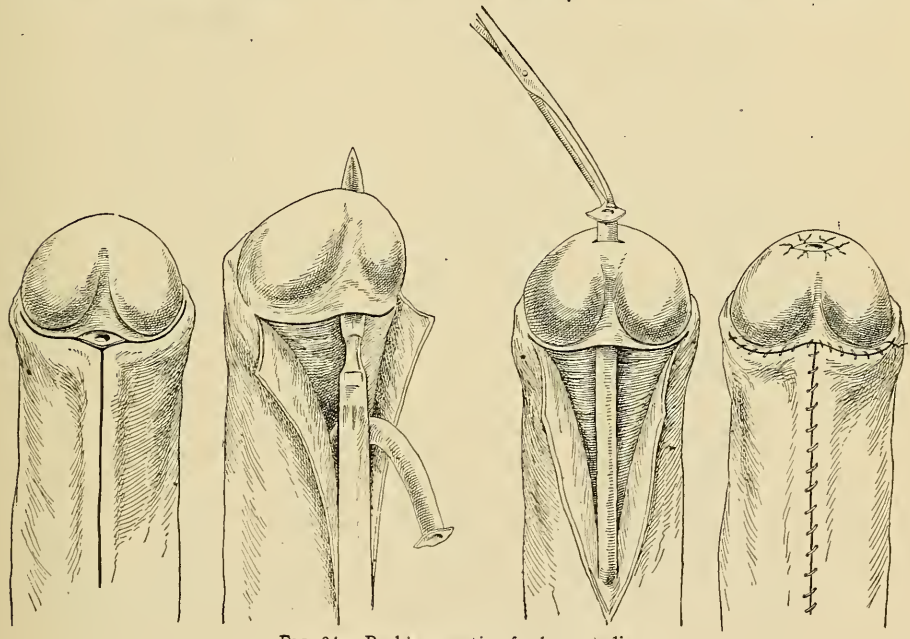


FIG. 84.—Beck's operation for hypospadia.

The wound is dressed with a narrow strip of sterile gauze secured in place by collodion. A few turns of a narrow gauze bandage are then applied, and the penis is held upward against the body between two layers of cotton, a crossed of the perineum roller bandage or a jock-strap securing it in place. Stitches are removed in five days. The penis is subsequently held by dressings in the same position till the next step in the operation is undertaken.

At the time the penis is straightened a portion of the second stage (*i.e.*, the formation of the glandular urethra) is accomplished. Where there is a deep furrow representing the roof of the urethra, freshening of its lower edges and apposition by suture may be sufficient. Usually a deep vertical incision or two lateral incisions, one on the upper and outer wall of each side of the groove, will be required. In the furrow thus deepened is laid a section of catheter

corresponding in circumference to the normal calibre of the urethra, and the freshened edges of the furrow are neatly approximated by suture, two or three silk threads being used (Fig. 83). These are removed in ten days. The section of catheter may be retained by tying its ends together. Before proceeding to the formation of the penile urethra it is well to wait for some months, to determine whether or not incurvation of the penis will be reproduced by contraction.

The second stage, the formation of the new urethra, is accomplished by freeing sufficient of the urethra already present to permit its being stretched to the required length, by means of epithelial grafts, or by means of flaps of skin taken from the penis or scrotum.

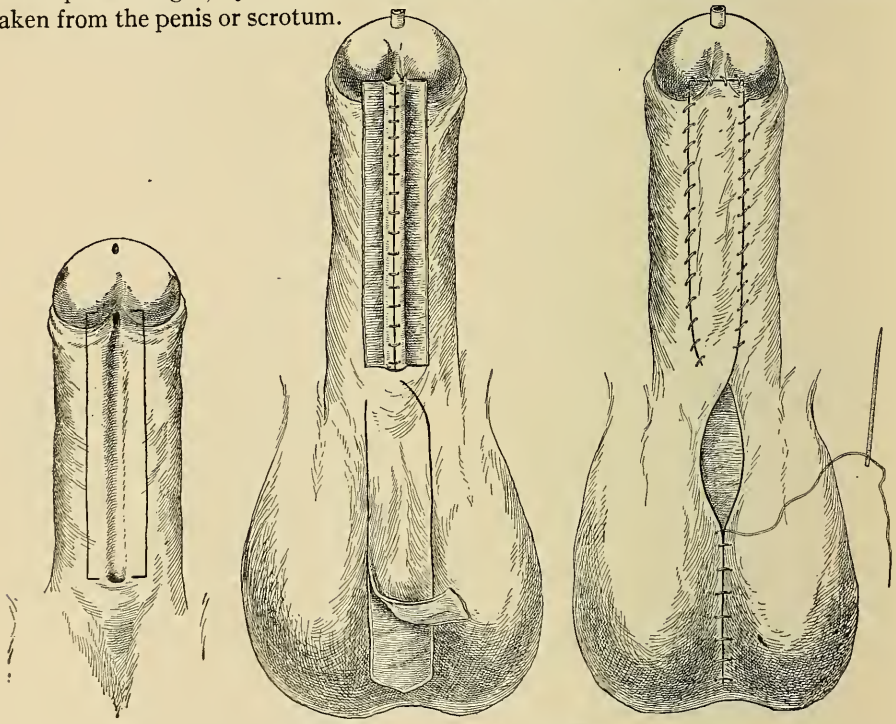


FIG. 85.—Flap operation for hypospadia.

The first method, Beck's operation,[1] should be used only when the hypospadic opening is close to the glans, and there is little or no incurvation (see Fig. 84).

Bevan[2] describes the operation illustrated in Fig. 86. It is applicable to cases of glandular hypospadia, and to those of the penile form opening within one inch of the glans. It does not shorten the under surface of the penis as does the Beck operation; an ideal result was obtained by Bevan in his single case.

The free-graft method as developed by Nové-Josserand employs skin taken from the thigh to line a tunnel made subcutaneously by means of a trocar.[3]

[1] Beck: *New York Medical Journal*, January 29, 1898; May 13, 1905; and August 14, 1909.

[2] *Journal of the American Medical Association*, 1917, lxviii, p. 1032.

[3] Nové-Josserand: *Arch. gen. de chir.*, 1909, iii, pp. 331–348.

The exact plan to be followed in forming a new urethra by utilizing flaps of skin from the penis and surrounding structures necessarily varies with the requirements of the individual case. Tension is fatal to vitality; in planning flaps the changes likely to follow erection must be kept in mind.

The usual plan after after perineal drainage by catheter is to make two parallel incisions, three-quarters to one inch apart, on the under surface of the penis from a little to the proximal side of the hypospadic opening to the base of the glans, continuing the incision about both openings, and dissect up flaps toward the median line sufficiently long to permit suture of their edges to one another (Fig. 85). The suture is continued at each end so that the new canal unites with the natural channel and the recently formed balanic portion. The raw

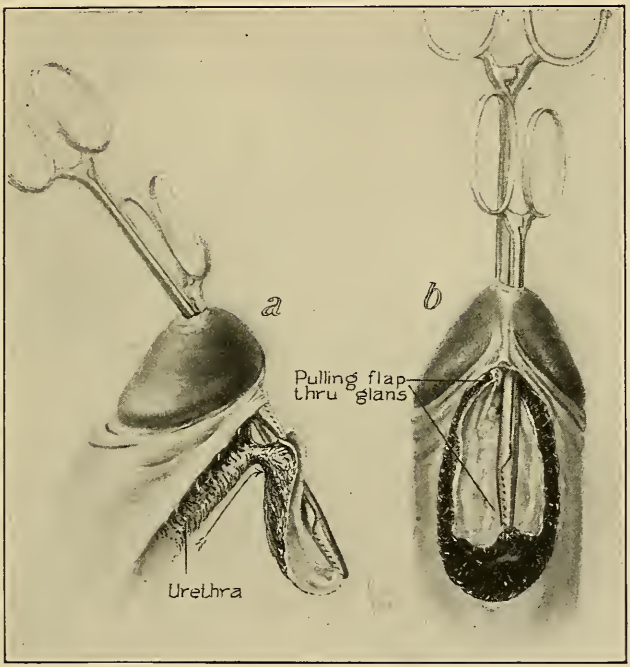


FIG. 86.—Bevan's operation for hypospadia.

area formed by turning over the flaps may be covered in by simply drawing the margins of the skin together (if sufficient skin be present) or by using a flap from the scrotum or the prepuce (buttonholing it so that it can be slipped over the glans, and cutting it so that the two layers can be separated).

If perineal drainage has not been provided for by urethrostomy or catheter, continuous urethral catheterization is indicated for seven to ten days. The rubber causes an undue inflammatory reaction, and the bulk of the catheter increases the tension on the sutures and the danger of pressure necrosis.

The postoperative dressing is a small piece of sterile gauze, secured by a tight circular bandage if the penis be large enough to be so treated, or simply laid on loosely if bandaging be not possible. Erections can be prevented only

by almost toxic doses of the bromides, scopolamine, and morphine; flaps should therefore be of such proportions as to allow for them. Rest to the part (bed treatment for children, and good bandage or athletic supporter for adults) is essential.

The perineal fistula should not be closed till the postoperative inflammatory reaction has subsided, and the new urethra takes easily a sound of appropriate calibre (28 F. to 30 F. for the adult; 18 F. to 22 F. for children). The closure is effected by deeply incising the mucocutaneous junction and uniting the superficial tissue and skin by sutures.

EPISPADIA

In this deformity a portion or all of the roof of the urethra is absent, the canal being represented by a furrow traversing the mid-dorsal aspect of the penis. It is often complicated by exstrophy of the bladder, and is sometimes associated with other malformations, such as urachal fistula, imperforate anus, absence of the prostate, abnormalities of the corpora cavernosa, etc. This anomaly, rare in all its forms, may appear as the glandular form (*i.e.*, the urethra

FIG. 87.—Usual form of epispadia.

is complete as far as the glans, opening just behind this expansion of the spongy body); more often the abnormal opening is just in front of the pubic symphysis (Fig. 87), or rather in the normal position of this junction, since in many of these cases the pubic rami do not extend to the middle line.

In these cases the penis is short, broad, curved upward, at times twisted; the prepuce is redundant below, and there is a projecting belly-fold above, against which the dorsum of the glans is apposed. On drawing this down the urethral furrow is seen lined with thin mucous membrane and passing backward

to the urethral orifice deeply sunken in the pubic region. This orifice is usually large, often admitting an examining finger without difficulty.

Epispadia is often attended with incontinence of urine, though when the posterior urethra is perfectly formed and there is no separation of the pubic bones micturition may be accomplished normally. Except in cases of marked curvation of the penis, erection and intromission are possible.

Treatment.—The treatment of epispadia is either palliative (*i.e.*, the adaptation of a properly fitting portable urinal (see "Exstrophy")—or radical—*i.e.*, by operative measures. Here, as in hypospadia, plastic repair is difficult, and is accomplished as the result of a series of operations, planned with due respect to the character of the tissues available in the individual case. Flaps subject to tension or of poor vitality will not hold; it is therefore quite useless to use such tissue.

The following is a description of Thiersch's method:

There are five distinct periods of the operation.

The first period is devoted to the formation of a perineal fistula. This is readily done by inserting into the urethra a curved forceps. The end of the latter is pressed downward and forward into the perineum and cut open, care being taken not to injure the rectum. This can be guarded against by passing a finger of the left hand into the anus while the perineal cut is being made.

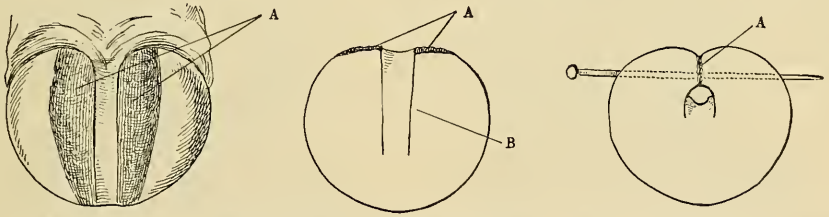


FIG. 88.—Formation of glandular urethra. *A*, freshened areas on each side of furrow. *B*, deep incisions on dorsum of glans.

The bladder having been thus opened, a Guyon self-retaining rubber catheter is introduced. If there has been excoriation of skin from leaking and decomposition of urine, it is well to postpone the further steps of the operation until thorough cleansing of the parts and the application of astringent and mildly antiseptic dusting powders have subdued all irritation. This perineal fistula, by diverting the urine from the seat of subsequent operations, enables the surgeon to avoid the dangers and delays incident to suppuration, which almost inevitably occurs when the urine is allowed to escape in its natural course.

The second step of the operation consists in the formation of a glandular urethra. To the right and left of the glandular furrow, parallel with the latter, running the whole length of the glans, and in depth equalling three-fourths of its thickness, there are made incisions converging to such an extent that were they continued to the lower surface of the glans they would meet (Fig. 88). By these cuts there are formed two lateral flaps and a middle wedge-shaped piece of glandular tissue, the broad base of the latter looking upward and being covered with epidermis. Along the outer border of each incision there is removed a strip of the glandular covering, so that when these lateral flaps are

brought together fresh surfaces of sufficient breadth to assure firm union will be apposed. These lateral flaps are approximated over the middle wedge and united by two or three harelip pin sutures. The canal thus formed is more deeply placed at its orifice than in the region of the corona, though this is of minor consequence. Obliteration of this canal is impossible, since the epithelial covering of the middle wedge prevents it.

The next step of the operation consists in transforming the penile furrow into a canal. Close to the right border of the furrow there is made a longitudinal incision dividing the skin and the subcutaneous tissues the entire length of the furrow (Fig. 89). From either end of this incision a transverse cut is made running outward, thus outlining a long quadrilateral flap. This is dissected up

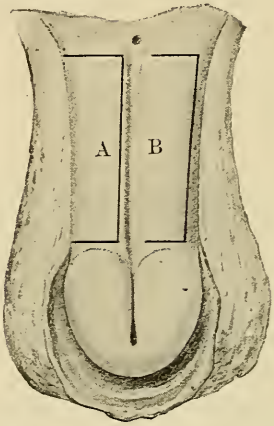


FIG. 89.—Outlining of flaps to form penile urethra.—A, flap dissected outward; B, flap dissected inward.

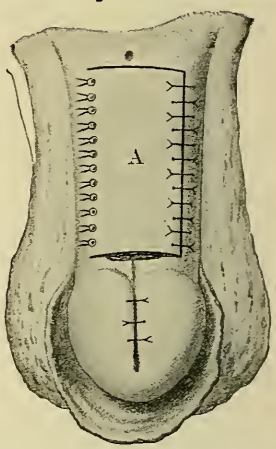
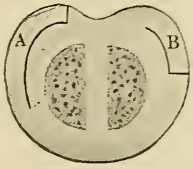
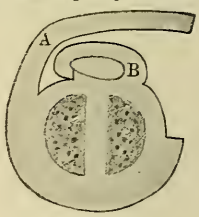


FIG. 90.—A. Flaps folded over and held in position by sutures.—Long flap drawn to the left side of the penis; stitches holding the short inner flap in position.



Cross-section of same, showing the direction in which the flaps are dissected.



Cross-section of same

with as much subcutaneous tissue as possible, especially near the base of the flap. A similar long incision is made to the left of the furrow, about two-fifths of an inch from its edge. From each end of this incision a transverse cut is carried inward as far as the edge of the furrow. This flap is also dissected up with as much subcutaneous tissue as possible. It is then turned over exactly as one turns the leaf of a book from right to left, so that its epithelial surface forms the roof of the furrow, while its wound surface is turned outward. If the flap is sufficiently wide to cover in the furrow entirely without undue tension, three or four mattress sutures are passed through its free border and the base of the right flap and tied on the skin surface. The first or right flap is now

drawn directly over this flap which has been turned over, thus approximating the two fresh surfaces of the flaps, and sutured in this position (Fig. 90).

The canal thus formed is lined with skin and is of the right calibre. There is no danger of the flaps sloughing provided they have been left sufficiently

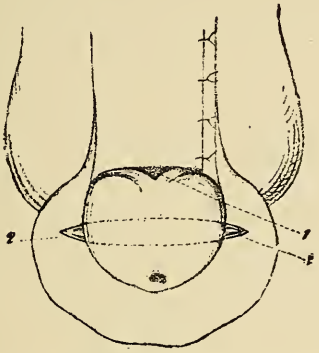


FIG. 91.—1. Transverse defect between penile and glandular urethras; 2, 3, oblique incision through foreskin. (Thiersch.)

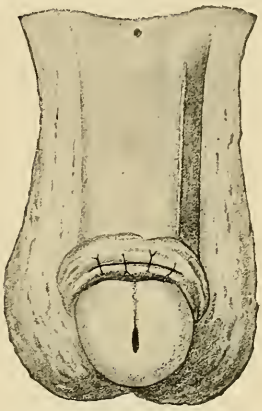


FIG. 92.—Foreskin brought up behind the glans, and line of sutures uniting freshened edges of transverse defect to foreskin.

thick at their base and have been dissected so freely that there is no tension. Should there be dangerous tension, two long incisions are made to the right and left of the lower mid-line of the penis. These are carried down to the fibrous sheath, and are allowed to heal by granulation.

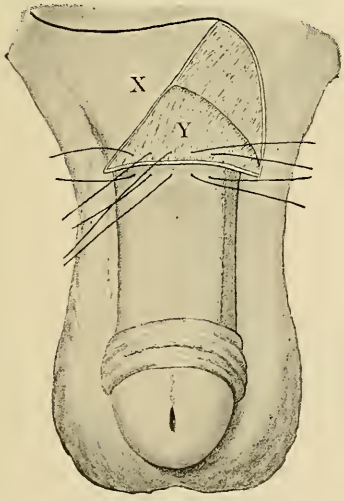


FIG. 93.—Closing posterior defect.—Formation of flaps X and Y; suture of first flap.

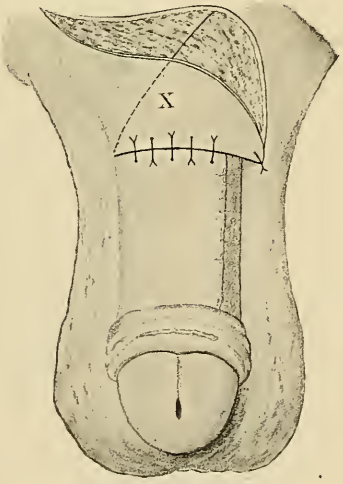


FIG. 94.—Suture of second flap.

The next step of the operation consists in the union of the glandular and penile urethras. This is made at the expense of the foreskin. The transverse defect existing between the penile and the glandular urethra is first widely freshened. The foreskin is stretched out and an oblique incision is made

entirely through it, forming an opening sufficiently large to allow the glans to slip through (Fig. 91). The lower half of the foreskin is thus by its raw surface closely applied to the corona. The foreskin having been brought up in place, one of its layers is carefully sutured to the upper border (formed by the new urethral roof) of the defect, and the other border is secured to the freshened corona glandis (Fig. 92). It is necessary carefully to separate the two layers of the foreskin, otherwise they will unite to each other instead of to the freshened surfaces.

The final step of the operation consists in closing the posterior defect, and

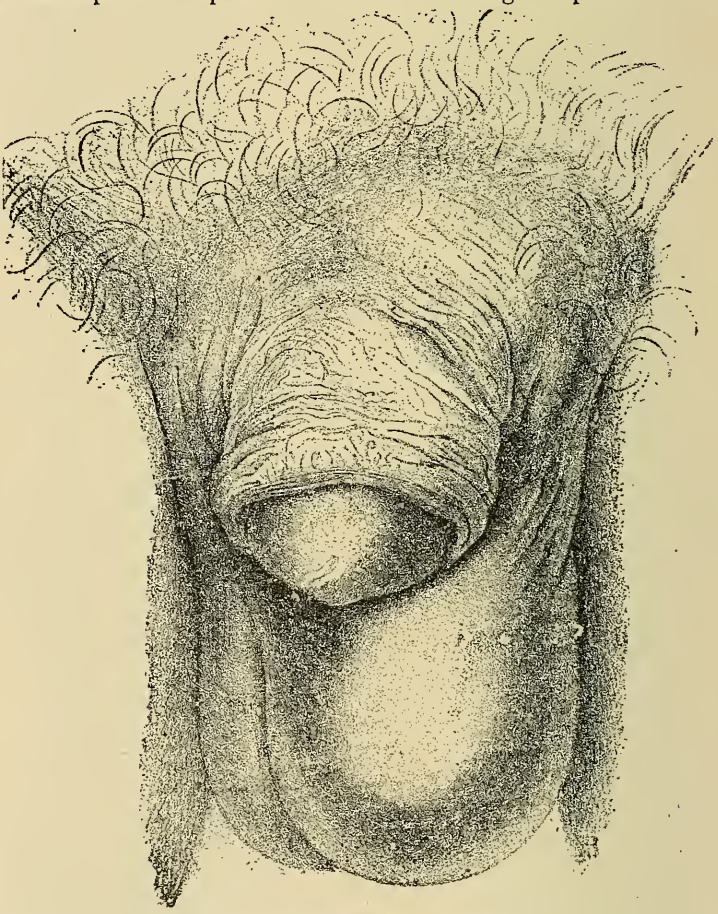


FIG. 95.—Cured epispadia. (Thiersch.)

is accomplished by means of two flaps cut from the surrounding belly walls. The first flap is formed from the left side. It is in the shape of an equilateral triangle, with its base corresponding to the left half of the skin surface lying immediately above and to the left of the roof of the urethral orifice (Fig. 93). The corner of this flap is folded downward and inward so that its skin surface covers in the defect. Its lower free border is sutured to the freshened upper

border of the new roof formed by transplantation of the penile skin. The second flap approximates the form of a quadrilateral with its attached base in the region of the right inguinal canal. This flap is drawn downward and inward so that its freshened surface covers in the fresh surface of the first flap. It is secured in this position by sutures, including both the lower flap and the borders of the skin incision required for the preparation of the triangular flap (Fig. 94). The raw surface left after this transplantation is allowed to heal by granulation.

Healing of the perineal fistula completes the operation. This is readily accomplished by removing the tube.

In Thiersch's own case (Fig. 95) it required about one and a half years. He holds that ordinarily it should be accomplished in three or four months. He advises that the various steps of the operation be performed in the order given, allowing fourteen days for the formation of the perineal fistula, fourteen days for forming the glandular urethra, twenty-one days for closure of the perineal furrow, fourteen days for transplantation of the foreskin, and, finally, for the closure of the urethra and the subsequent operations which may be necessary, forty-two days.

INJURIES OF THE URETHRA

The urethra may be wounded or subcutaneously ruptured.

Wounds of the urethra are surgical or accidental. Accidental wounds are rare.

Incised wounds of the urethra, if longitudinal, heal readily and often without subsequent stricture, even though no sutures are applied. When such injuries are inflicted from without, either intentionally by the surgeon, as in the case of external urethrotomy, or as a result of accident, provided the urethra is healthy and the urine sterile, the wound may be sutured, the urethra being first closed by fine buried catgut sutures, not including the epithelial coat, and the skin, subcutaneous tissues, and spongy body being approximated by a second row of interrupted fine silkworm-gut sutures. When the urethra is suppurating the wound should be allowed to heal by granulation. When the urethral wound is not extensive it is not necessary to employ stitches.

When the urethra is incised transversely there is free bleeding, and, if the canal is cut completely across, the proximal end retracts. Healing by granulation always implies a degree of coarctation depending on the extent of the wound. When the urethra is completely divided, the proximal end may be found by retrograde catheterization through a suprapubic opening in case it has retracted so that it is not easily secured in the wound. The divided urethral ends must then be held in neat apposition by interrupted catgut sutures placed one-eighth of an inch apart and not penetrating the epithelial layer. When the continuity of the roof of the urethra is thus restored by three or four sutures, a soft catheter is passed into the bladder, the urethral suture is completed, the external wound is closed, and the catheter is tied in place; as in all cases of continuous catheterization, the bladder and urethra receive frequent antiseptic irrigations.

Always after the healing of transverse wounds of the urethra involving more

than one-third of the circumference of the canal a sound should be passed at first once a week, then at longer intervals, till there is no tendency to stricture formation.

Lacerated and contused wounds of the urethra are cleansed, opened so that drainage both of urine and of wound discharges is freely provided for, and allowed to heal by granulation, continuous catheterization being maintained till the urethral defect is entirely closed in. Patients after these injuries must be instructed as to the probable necessity for the occasional passage of a sound during the remainder of their lives.

Whenever, because of the limited extent of a lacerated and contused wound, there is sufficient tissue left, after trimming away that which is devitalized, to allow of urethral suture, this procedure should always be adopted, since thus subsequent stricture may be lessened or entirely prevented.

Punctured wounds, when from without, are not attended by extravasation, and require simply the application of wet antiseptic and evaporating lotions, as, for instance, lead water and alcohol, to limit inflammatory reaction. When the urine is sterile no intra-urethral treatment is required. When it is infected, and particularly when the urethra is inflamed, as in acute or chronic gonorrhœa, irrigation with protargol solution 1 to 2000, or bichloride 1 to 20,000 is indicated.

When the punctured wound is from within, as in the formation of a false passage, free bleeding and the detection of the point of the instrument outside the urethra by external or rectal palpation show the nature of the injury. Usually such wounds heal spontaneously without becoming infected, even though infection of the urethra has existed previously. Exceptionally they suppurate, forming abscesses.

The *treatment* of such wounds consists in refraining from further instrumentation, making the urine slightly antiseptic by appropriate medication, and using mild antiseptic irrigation, 1 to 2000 protargol or 1 to 6000 permanganate, under low pressure (elevation of reservoir, three feet). In case of local and general symptoms pointing to suppuration, drainage must be provided for by external incision.

Rupture of the Urethra.—Subcutaneous rupture of the urethra when seen in the penile portion of the canal is usually the result of the breaking of chordee, fracture of the penis, or twisting, wrenching or pinching force applied to the erect organ. The penis is so movable that it usually escapes the crushing effect of force applied in the form of blows and kicks. Subcutaneous rupture is commonly observed in the perineal urethra. Kaufmann, as the result of a statistical study of over two hundred cases, gives as the form of injury, falling astride eighty per cent., perineal blows twelve per cent., being run over by vehicles four per cent., being unseated upon the pommel of the saddle four per cent.

The mechanism of the perineal rupture depends upon the shape of the vulnerating body and the direction in which the force is applied. Where there is a fall astride upon a narrow body, as, for instance, the edge of a half-inch plank, this is forced upward between the ischiopubic rami, usually a little to one side, tears the triangular ligament, and crushes the urethra against the ischio-

pubic ramus. When the vulnerating body is larger, as, for instance, the square toe of a boot, the urethra is driven directly upward against the lower or anterior surface of the pubis, the lower portion of the urethra rupturing first. Together with the urethral rupture there are always contusion of the bulb, of the perineal tissues, and often of the attachment of the cavernous bodies.

The seat of contusion and laceration of the urethra is usually in the bulbous part of the urethra, except when there is fracture of the pelvis or disjunction, temporary or permanent, of the pubic symphysis, in which cases the membranous urethra is involved.

The rupture may be partial or complete. In the mildest cases the spongy tissue is the only part involved. There results in consequence a temporary narrowing or blocking of the urethra, due to circumscribed blood effusion into the loose erectile tissue of the spongy body. In more severe cases both the spongy body and the mucous and sub-mucous layers of the urethra are crushed and torn. In the most severe cases not only is the urethra with the surrounding spongy body injured, but likewise the fibrous investment of the latter, thus making a direct communication from the floor of the urethra to the loose cellular tissue of the scrotum and the perineum.

The rupture may involve the entire lumen of the tube, or, as is more frequently the case, may include only its lower and lateral wall. In cases of complete transverse laceration there is always marked retraction, leaving a space from one-half to three-fourths of an inch, at first filled with blood-clot, later converted into an abscess.

Symptoms.—The symptoms of laceration of the urethra are urethral hemorrhage, the immediate formation of a circumscribed tumor at the seat of injury, retention of urine, and pain.

The amount of bleeding from the urethra cannot be regarded as an index of the severity of the lesion. Blood escaping from the meatus after trauma always indicates laceration of the mucous membrane at least, and even though but a small quantity is lost, as in the breaking of a chordee or from a false movement in coitus, there is liable to result periurethral inflammation, with the ultimate formation of an unyielding stricture.

The immediate perineal swelling is due to extravasated blood. Skin discoloration appears after one or two days. When extravasation of infected urine takes place there are the symptoms of deep cellulitis, involving the scrotum and penis and extending upward over the abdomen. When there is total rupture retention is due to separation of the urethral ends and the interposition between them of masses of coagulated blood. In cases of partial rupture, obstruction of the tube from blood-clot and urethral spasm incident to the injury may be operative in causing retention. Retention developing some time after the accident is due to obstruction caused by inflammatory swelling.

In rupture of the posterior urethra there may be neither bleeding from the meatus nor any sign of perineal tumor. When urinary extravasation takes place it occurs in the deep tissues, and produces no symptoms until cellulitis has been set up. In cases of this character there is retention of urine; obstruction is not felt on introduction of the catheter until it has penetrated to the depth of six inches and is passing through the subpubic urethra. Then either

its further progress is arrested, or if it passes into the bladder and remains unobstructed by blood-clot there flows urine mixed with blood. In ruptures of the anterior urethra, when the bladder is once reached by instrumentation, the urine is clear.

The consequences of rupture of the urethra are urinary extravasation, septic infection, and later traumatic stricture. At each act of micturition urine is liable to be forced into the periurethral cellular tissue, extending at once into the scrotum or the perineum if the fibrous envelope of the bulb has been torn. This urine, even if originally sterile, shortly becomes infected, sets up cellulitis, and occasions sloughing and gangrene, which, unless the case is promptly attended to, result in death. In consequence of the nature of the injury (*i.e.*, a crush) there is, when the canal is not torn completely across, more or less sloughing, with subsequent cicatricial contraction, and often a most obstinate fistula. When the ruptured ends of the urethra have not been apposed, there is formed between them a granulating sinus, whose walls exhibit all the vices of cicatricial tissue. Because of its common association with fractured pelvis, the prognosis of rupture of the membranous urethra is guarded.

Diagnosis.—The history of the injury, the perineal tumor of sudden formation, blood from the meatus, either flowing spontaneously or induced to appear by pressure on the perineal tumor, are sufficient to justify an absolute diagnosis of rupture of the anterior urethra. Bleeding is in itself diagnostic when it follows traumatism, and in the absence of perineal tumor and marked dysuria denotes simply a slight tear of the mucous membrane without involvement of the periurethral tissues. A rapidly formed perineal tumor associated with dysuria or retention usually signifies an extensive laceration. The seat of rupture is indicated by local tenderness and often by the signs of external violence. The history of the injury is also of importance in determining this point. Thus, when there has been a fall astride of a comparatively wide surface, such as a joist or the pommel of a saddle, the bulbous urethra is almost certainly involved. If the injury has resulted from a fall on the edge of a board, for instance, it is probable that the membranous urethra is ruptured. In cases of pelvic fracture or disjunction the diagnosis is sometimes extremely difficult. There is little deformity, and crepitus may not be elicited. There may be bleeding from the meatus, but usually the spasm of the compressor urethræ muscle causes the blood to flow back into the bladder. The history of the injury—commonly, in case of fracture, a crushing force applied to the two sides of the pelvis—the detection of crepitus by rectal examination, the almost invariable development of urinary retention, and the difficulty in catheterization or the drawing off from the bladder of blood with the urine, would point to rupture of the membranous urethra.

Treatment.—In the least serious cases (*i.e.*, those characterized by moderate hemorrhage from the meatus, either with or without circumscribed nonprogressive tumor-formation in the perineal region, and not complicated by retention) the use of pressure, together with the application of hot compresses, the administration of urinary antiseptics by the mouth, rest in bed, free purgation, and mild antiseptic irrigation of the urethra, may bring about cure. The catheter should not be used unless dysuria or retention makes it necessary.

Under these circumstances a large, soft, elbowed gum instrument should be employed; and it should be introduced and withdrawn with a solution of protargol (1 to 2000) flowing through it from a fountain syringe elevated not more than two feet above the bladder level.

Perineal section is indicated in the presence of urinary retention when a catheter cannot be passed into the bladder, also by persistent hemorrhage, evidenced by progressive tumor formation or hæmaturia, in spite of continuous catheterization, and by cellulitis.

The operation is conducted in accordance with the principles laid down on page 285. Acatheter or staff is passed to the seat of rupture, and the perineum is opened upon this in the middle line. This can be done under local anæsthesia. The incision should be free. On opening the deep layer of the superficial fascia there is found a cavity filled with clots, with, in recent cases, bleeding still persisting.

Guided by the catheter, the urethra is readily identified, threads are passed through its two sides to act as retractors, and, in case the canal is not completely torn across, the catheter is readily passed into the bladder. Bleeding points are then secured by ligature, and the urethral rent is closed, if possible, by interrupted chromicized gut sutures, including in their grip as much periurethral tissue as possible. The cavity resulting from the bleeding is closed by buried catgut sutures and the skin is secured by silkworm-gut. The catheter is left in place from four to six days.

If the urethra is completely torn across and the proximal urethral end is not discovered after a brief but careful search, Guyon advises the passage of a sound from the meatus till its extremity is arrested by the posterior wall of the cavity made by the blood extravasation. The left index finger is then passed, palmar side up, to the point pressed upon by the tip of the sound. The latter is slightly withdrawn, and in many cases just above the position occupied by the end of the finger will be found the proximal end. Through it, guided by the finger, may be passed an instrument from the perineum into the bladder. Sudden bimanual pressure on the bladder by the fingers of one hand in the rectum and of the other over the hypogastric region may cause a few drops of urine to exude, and thus show the position of the torn mucous channel, which in recent cases is found to be a movable bleeding cord. When local anæsthesia has been employed, the patient may aid the surgeon by efforts at micturition.

When the case has advanced to abscess-formation and extensive sloughing, or when the rupture has occurred as a complication of pelvic fracture, it may be impossible to find the proximal end of the urethra except by means of retrograde catheterization practised through a suprapubic opening made in the bladder.

The proximal end of the urethra having been found, a soft rubber catheter is passed from the meatus into the bladder, and the ragged or irregular wound edges are trimmed off, and approximated over the catheter by means of chromicized catgut sutures, taking in the periurethral tissues. This suture is made easy by thrusting the proximal end of the urethra downward and forward well into the wound by means of a finger inserted into the rectum. Often union does not take place; but, even though it fails, less cicatricial tissue is formed

than when there has been no attempt at suture. When there is no local infection the whole wound is closed by buried catgut sutures, an antiseptic dressing being held in place either by a T-bandage or by a crossed of the perineum. Continuous catheterization is employed for six days (see p. 73). After the catheter is withdrawn a full-sized sound is passed every three, four, or five days for some weeks, and is afterwards continued at longer intervals for months or years.

Even when operation is delayed, and infiltration and septic inflammation have already occurred, approximation of the torn urethral ends should be attempted by suture.

There should, however, be no effort to close the infected cavity, this being cleansed and packed with sterile or iodoform gauze and allowed to granulate from the bottom.

FOREIGN BODIES IN THE URETHRA

Foreign bodies in the urethra are either introduced from without or pass forward from the bladder, in the latter case appearing as urinary calculi or fragments of neoplasm. The bodies introduced from without are usually segments of catheter, the instruments employed being old and breaking during introduction or withdrawal. In the case of social perverts almost any object, if sufficiently small, may be passed into the urethra. Exceptionally, animal parasites may be found.

The behavior of a foreign body lying completely within the urethra depends upon its shape and size. When it is smooth and rounded, as, for instance, in the case of a broken fragment of catheter, a small wax candle, or a piece of lead pencil, it nearly always exhibits a tendency to pass back into the bladder. This occurs in about thirty per cent. of all cases, and is due to the constant handling of the parts by the patient, and to the frequent erections reflexly excited by the presence of the foreign body.

A smooth, not too large foreign body may pass back into the bladder in less than a day.

Should the foreign body remain in the urethra, the navicular fossa, the bulb, and the prostatic urethra are its seats of preference, these portions of the canal representing the regions of greatest dilatation.

Symptoms.—Localized pain, interference with micturition, and inflammatory phenomena are the characteristic symptoms of foreign body in the urethra.

The pain is usually severe, especially when the foreign body is irregular in shape. When the catheter is broken off in a urethra which has long been tolerant of instrumentation, there may be no suffering, especially if the broken end is lodged in the membranous or prostatic portion. Foreign bodies located in the posterior urethra, particularly if irregular in shape, with sharp corners or angles, cause pain characteristic of posterior urethritis; *i.e.*, there is a deep ache felt in the perineum, with itching, burning, or a sense of weight and dragging in the rectum, and shooting or persistent pain in the hypogastric region, about the sacro-iliac articulation, and radiating down the inner surfaces of the thighs.

Interference with micturition depends mainly upon the size and position of the foreign body and upon the amount of inflammatory reaction its presence sets up. Immediate retention is rare. There are always increased frequency of urination and lessening in the force and volume of the stream. Unless the body is removed or passes back into the bladder, micturition becomes progressively more difficult and painful because of swelling due to inflammation.

Inflammatory phenomena are quickly developed. When the body is lodged in the anterior urethra, there is shortly a blood-stained muco-purulent discharge, with redness, heat, and swelling of the penis. This is commonly accompanied by fever.

When the body is lodged in the posterior urethra, increased tenderness on perineal and rectal palpation, the appearance of constitutional symptoms, and often the development of cystitis or epididymitis, show extension of inflammation.

Diagnosis.—The history of the case is usually sufficient to establish the diagnosis. In the case of a sexual pervert, a reliable history may be entirely wanting. The symptoms in themselves are merely suggestive, since pain, fre-

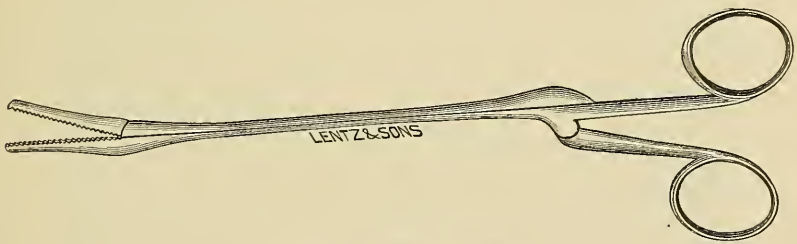


FIG. 96.—Urethral forceps.

quent and obstructed urination, and urethritis may develop from a variety of causes.

Direct examination, even in the absence of history, nearly always makes the nature of the case plain. Palpation usually shows the size, shape, and seat of the body if it is located in the anterior urethra. Rectal palpation is employed when the foreign body is farther back.

Providing the urethra is not strictured, the urethroscope can always be depended upon to bring the foreign body into view. This instrument also enables the surgeon to determine the amount of impaction, and to choose and apply his extracting instruments so that they shall act to the greatest mechanical advantage.

In introducing the urethroscopic tubes, care must be used not to push the foreign body in still farther.

In the absence of an urethroscope a small sound may be used for purpose of diagnosis and localization.

A foreign body introduced into the urethra, if neither expelled nor extracted, may pass back into the bladder or may remain in the urethra, becoming

incrusted with urinary salts and causing ulceration which is prone to extend through the urethral wall, forming a suppurating cavity which opening externally may result in an obstinate urethral fistula. It is in the prostatic urethra that foreign bodies are most apt to remain indefinitely, causing slow ulceration, and becoming so embedded in inflammatory material that their detection may be extremely difficult.

A foreign body once lodged within the urethra if not expelled with the first subsequent act of micturition is not likely to be expelled afterwards. Inflammatory swelling fixes it more firmly, and from reflex irritation causing frequent urination the stream loses in volume and force.

Treatment.—The simplest method of ridding the urethra of the foreign body, and one which may succeed providing the case be seen immediately after its introduction, is to direct the patient to urinate forcibly. When the stream is fairly started the lips of the meatus are pressed together for four or five seconds and are then suddenly released. This failing, recourse should be had at once to forceps, manipulated through an urethroscope (Fig. 96). In grasping the body with forceps it should be pressed forward from behind by perineal or rectal pressure, thus avoiding the danger of pushing it back into the bladder.

If the forceps fail to grasp the body, or if because of its angular shape withdrawal requires so much traction that extensive laceration of the urethra is liable to result, the patient should be put in the lithotomy position and the body removed through a perineal or penile incision carried down to it in the middle line. The resulting wound is closed by a buried catgut suture including the urethra and its fibrous investment, but not the epithelial layer of the mucous membrane, and skin stitches of silkworm-gut or silk.

Special manipulations may be serviceable in certain cases. Thus, should the foreign body be a gum catheter, a lead-pencil, or other non-metallic body, and should the forceps fail to grasp it, ordinary round-pointed sewing needles may be driven into it through the urethra, and by means of these, the elasticity of the urethral walls allowing some play to the needles, the foreign body gradually may be brought to the meatus.

A pin, nearly always introduced head first, may be extracted by driving its point through the urethral walls, thus rendering it easy to seize the head in the forceps within the urethra.

URETHRAL CALCULI

Exceptionally calculi are formed within the urethra, in which case they are phosphatic. Usually they come from the kidney or the bladder, and, though apparently phosphatic from incrustation, show a uric acid nucleus. They are most frequently observed in infancy and past middle age. Their common seats are the bulbomembranous and prostatic regions and the navicular fossa. Calculi rarely form spontaneously in the urethra behind a stricture, the stagnation not being sufficient to allow of this; it is in urethral pouches or diverticula, or in the suppurating blind pouches resulting from glandular inflammation complicating urethritis, that calculous formation most frequently takes place.

The direction of growth from incrustation is dependent upon the pressure exerted by the urethral walls. The layers of lime salt are so deposited as a result of this pressure that the growth is backward. As the calculi increase in length they are liable to be segmented by fracture; hence in many cases several

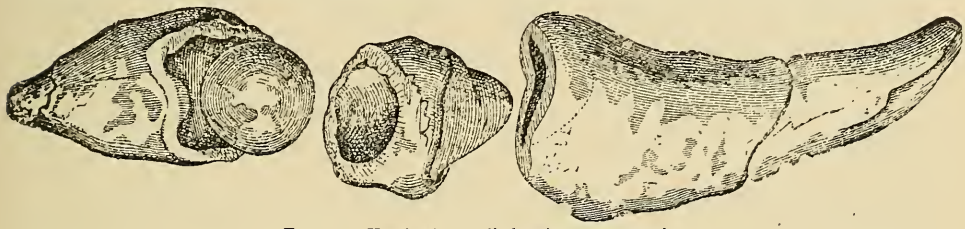


FIG. 97.—Urethral calculi showing segmentation.

calculi are found placed in line and articulating with one another (Fig. 97). Prostatic calculi growing backward encounter much peripheral resistance in the region of the vesical neck. Having passed this, there is nothing to prevent

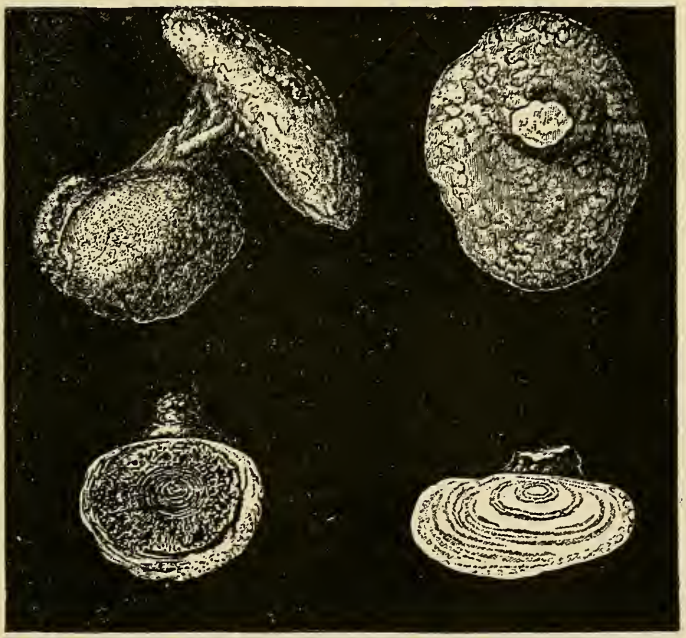


FIG. 98.—Urethral calculi showing mushroom shape. Cross-sections to exhibit lamination.

their extension in all directions; hence these calculi often exhibit two nodules connected by a narrow bar (Fig. 98).

The growing calculus may cause great dilatation of the infantile urethra. In adults ulceration is more common, the calculus escaping into the periurethral tissues, and sometimes in this position attaining great size before it reaches the surfaces or causes inflammation or urinary infiltration sufficiently serious

to require operation. Usually the ulcerating cavities in which these calculi lie open externally. In about twenty per cent. of cases urinary infiltration occurs. A calculus which has thus left the urethra, and which lies in a cavity which communicates with the latter only by a narrow opening, cannot be detected by the passage of urethral instruments.

Symptoms.—Calculi which form in the urethra give no other symptoms than those due to the inflammation and gradually increasing obstruction; *i.e.*, urethral discharge and increased frequency of urination followed by dysuria. Impacted calculi from above occur in those who have passed gravel or have had attacks of nephritic colic. In children these symptoms are generally absent. The lodgement of the stone occurs during urination. There is sudden partial or complete stoppage of the stream, with the sensation of a solid body having lodged in the urethra. This is followed by the symptoms of foreign body in the urethra (see p. 162). The X-ray gives positive information.

Diagnosis.—Given the sudden stoppage of the stream during urination and the sensation of a foreign body having slipped into the urethra, with a precedent lithuric history, the diagnosis is reasonably certain. It is further confirmed by palpation of the urethra, which may show a hard body, but more commonly elicits only localized tenderness, and by the use of the urethroscope. In the absence of the urethroscope a small metal sound should be employed; this in striking the stone gives a click showing the position and nature of the obstruction, or, this failing, rectal examination may enable the stone to be felt lying between the finger and the sound. Stones lying in diverticula or in periurethral abscesses can usually be detected only by palpation.

The consequences of the impaction of stone in the urethra are not often serious. In cases of stricture with damaged kidneys, complete retention, if not promptly relieved, may have disastrous consequences. The symptoms of impaction are, however, so marked that treatment is promptly instituted; hence there is little chance for grave systemic disturbances. Stones which have ulcerated through the urethral walls always expose the patient to the danger of urinary infiltration.

Treatment.—The treatment is practically the same as in the case of foreign bodies. Immediate removal of the stone is the prominent indication. If it is situated at or near the navicular fossa, meatotomy may be required. Calculi in the prostatomembranous urethra which cannot be grasped readily by forceps, or which, if grasped and drawn upon, show such resistance that extensive laceration of the urethra is certain to occur, should be pushed into the bladder by a bougie, and then crushed and evacuated. If this pushing back into the bladder requires force, they should be cut down upon and removed, the urethra and wound being closed by buried sutures. Calculi in any part of the urethra which are firmly embedded should be treated in a similar manner. When the calculus lies behind a stricture, this should be divided by internal urethrotomy if it lies anterior to the bulb, by external urethrotomy if it is bulbomembranous, the stone then being removed either through the meatus by forceps or through the perineal wound. Stones lying in extraurethral abscesses should be removed by incision, the opening into the urethra being freshened and closed by catgut sutures and the abscess-cavity being drained by packing.

FISTULA OF THE URETHRA

Fistula of the urethra is an abnormal opening through which the urine escapes from this canal, either into the rectum, the vagina, or externally. Very exceptionally these fistulæ are congenital, and are due to the establishment of the function of the kidney before the urethral canal is fully formed.

The usual cause of urethral fistula is slow leakage of urine incident to ulceration behind a stricture, though suppurative folliculitis and periurethral abscess occurring in the course of acute or chronic gonorrhœa, the lodgement of a stone or of a foreign body, or rupture or wound of the urethra may result in fistula formation.

In accordance with the position of the opening and course of the tract the fistula is named urethrorectal, urethroperineoscrotal, urethropenile, or urethrovaginal.

Urethrorectal fistulæ of the noncongenital varieties are due to rectal trauma inflicted in the course of perineal operations, particularly prostatectomy, or to the slow backward extension of prostatic abscess, the ulceration ultimately reaching and destroying the rectal wall, and forming a small opening, except in cases of acute inflammation. Tuberculous or malignant infiltration, whether primary in the urethra or in the rectum, often causes the tissues lying between to break down.

Finally, a foreign body or calculus long retained in the prostatic urethra may produce urethrorectal fistula. In such cases the urethral opening is usually small, and is generally in the prostatic portion of the canal, at the side of the verumontanum, the course of the fistula being obliquely downward and backward. In addition to the rectal opening there is often a tract opening into the perineum. Other tracts may form, passing back to the perineum and to the ischiorectal region, or through the great sacrosciatic foramen opening near the hip joint, or upward on the belly-wall.

The fistulous tract forms a dense, cord-like band, easily felt on rectal examination, when there is not much infiltration of surrounding tissues. The opening into the rectum is placed within the sphincter, and may be so small and so well covered by rectal folds that the finding of it is difficult; in malignant and tuberculous cases it is marked by a button of exuberant granulations. Following large, rapidly extending abscess of the prostate there is decided loss of substance, the opening then being of considerable size. The contact of the urine often produces an inflammatory condition not only of the rectal mucosa but also of the skin surrounding the anus.

Symptoms.—Pathognomonic symptoms of urethrorectal fistula are the passage of urine by the rectum and exceptionally the escape of gas and of fæces through the urethra.

The quantity of urine passing into the rectum varies in accordance with the size of the fistula. When the urethra is not obstructed, but a few drops escape in this direction. These usually appear externally during or immediately after urination, though sometimes the urine is retained and is discharged by the motions of defecation, exactly as would be a liquid stool. Gas and fæces may escape from the urethra either during or after defecation.

On rectal examination the nodular induration characteristic of a fistula is easily detected. By means of a speculum the opening of this tract can be found and a probe can be passed through it, encountering the surface of a sound passed through the urethra and into the bladder. The urethral orifice can sometimes be detected by urethroscopic examination, and positive diagnosis may be made by forcing a colored liquid, such as one-tenth per cent. methyl-blue solution, into the urethra, and noting whether or not it can be seen in the rectum. Or equally decisive is the injection of hydrogen peroxide into the rectal opening of the fistula, the bubbles due to oxidation then appearing in the urine.

Diagnosis.—The differential diagnosis of urethrorectal from vesicorectal fistula is made by cystoscopic examination and by injection of colored fluids in moderate quantity directly into the bladder with the patient in the dorsal decubitus. If the fistulous opening be in the urethra, this solution will not appear in the rectum till the patient urinates. In urethrorectal fistula urine usually escapes only during the act of micturition, and the inflammation of both the rectum and the bladder is much less marked than when the opening is directly into the latter viscus.

Tuberculous urethrorectal fistulæ are associated with irregularly nodulated prostates and usually with infiltration and nodulation of one or both seminal vesicles, with great thickening of the tissue lying between these two pouches; tuberculous cystitis and epididymitis are often present. Urethrorectal fistulæ occur in malignant disease only when the infiltration is so well marked as to be practically unmistakable.

Prognosis.—The prognosis of urethrorectal fistula in tuberculous and cancerous cases is hopeless; even in simple ulceration, if there has been much destruction of tissue, the chances of ultimate cure are extremely slight. If the fistula is small it may heal spontaneously, especially after the relief of urethral obstruction, which has tended to keep it open. The consequences of an uncured fistula of this kind are usually grave, since both the rectum and the bladder become chronically inflamed, and are subject to the immediate and remote complications incident to such inflammation.

Treatment.—Spontaneous cure may take place after fistulaformation resulting from suppuration of a prostatic gland. This is rare. The most important point in treatment is to remove obstruction from the urethra. Although stricture is not a common cause of this form of fistula, when once the abnormal opening is formed a very slight urethral narrowing may be sufficient to keep it open indefinitely.

If restoration of the urethral canal to its normal calibre is not followed by cure of the fistula, the tract of the latter should be protected from the irritation incident to the passage of urine and fæces by regular catheterization, or, better still, continuous catheterization kept up for several weeks, and by the checking of diarrhœa and over-stretching of the rectal sphincter. Perineal and ischiorectal tracts, together with their diverticula, should be opened, curetted, and forced to heal from the bottom by packing.

The fistula still remaining open, repeated cauterizations of the rectal orifice and of the whole tract by a stick of copper sulphate or silver nitrate, or by the galvano-cautery, may be tried, but will succeed only in case the suppurating canal is very small.

These means having failed, a curved incision is made across the perineum in front of the anus, this orifice lying in the concavity of the curve. This incision, identical with that employed for exposing the prostate, is deepened till the rectal and urethral orifices of the fistula are exposed and made accessible. In this dissection a finger introduced into the bowel and a sound passed through the urethra into the bladder will enable the surgeon to avoid wounding either of these structures. The two orifices having been exposed, and the main tract and its diverticula having been opened, dissected out, the edges of each fistulous opening are denuded and closed by catgut suture introduced as in the closing of vesicovaginal fistula. When the tract is small and fairly direct and the surrounding tissues are healthy, the perineal wound may be closed by buried catgut sutures. When there is wide infiltration the wound should be packed and allowed to heal from the bottom.

Malignant fistulæ are not helped by this operation.

Urethroperineoscrotal Fistula.—This fistula, by far the commonest of all, is usually due to ulceration behind a stricture, though traumatism, erosion by stone or foreign body, acute abscess, ulceration extending from caries or necrosis of the pelvis, or tuberculous or gummatous infiltration, may occasionally cause it. The urethral orifice is generally single, but externally there may be several openings, due to the fact that the one first formed has a tendency to contract slowly, thus obstructing the flow of urine, which then burrows in various directions. In cases of urinary extravasation from traumatism several fistulæ may be formed at the same time.

Occasionally the cutaneous orifices of the fistula are placed well back on the buttocks, down the thighs, in the region of the hip, or in the belly-wall, though usually they are found in the perineum and scrotum. The fistulæ form dense fibrous tracts easily detected by palpation. Some of these tracts end in blind pouches. They are lined by unhealthy granulations, rarely by epithelium. Occasionally calculi are formed in their interior, or their walls become incrusted with urinary salts. The skin and subcutaneous tissue of the scrotum and perineum may be enormously thickened, producing a condition much like elephantiasis. Large fibrous nodules of partially organized inflammatory tissue may form about the fistulous orifices.

Diagnosis.—The diagnosis is made by the escape of urine from the surface openings of the fistula. When the openings are so small that little or no urine escapes the diagnosis may sometimes be established by holding the meatus shut during urination, or by injecting hydrogen peroxide or a colored solution into the urethra with a syringe.

The differential diagnosis between urethroperineal and perineoanal fistula is founded on the history of the case, and the results of examination with a probe and by the injection of solutions. Exceptionally there are openings into both the urethra and the rectum.

Sinuses dependent upon chronic suppuration of Cowper's glands or of the urethral glands can be diagnosed from fistulæ only by the absence of urine leakage and the negative results of pressure injections.

Treatment.—The formation of these fistulæ may be prevented by prompt suture of the urethra in case the canal is ruptured or wounded either surgically

or accidentally; by the immediate evacuation and packing of glandular and periglandular urethral abscesses, followed by continuous catheterization; and by the dilatation of strictures before they give obstructive symptoms.

A perineoscrotal fistula having formed, complete restoration of the urethra to its normal calibre is the first essential in successful treatment. The partial cure of stricture is in these cases unavailing. Usually when the calibre of the urethra is carried up to the point indicated in the scale given on page 257, the fistula, unless its walls are too densely indurated or have been covered with pavement epithelium, will heal spontaneously. At times continuous catheterization, supplemented by cleansing and stimulating the fistulous tracts, will accomplish a cure.

The most satisfactory method of treatment, after having brought the urethra to full calibre, is by external urethrotomy, with a curettement or excision of the fistulous tracts, including the removal of all fibrous nodules. If a catheter is well tolerated, continuous catheterization should be maintained for two or three weeks.

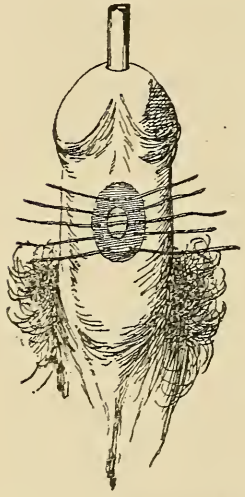


Fig. 99.—Closure of fistula.

Urethropenile fistula is usually encountered as a short, straight, single, nonindurated channel, lined with pavement epithelium, passing by the shortest route from the urethra to the surface, though exceptionally when urinary extravasation has taken place from the midpenile portion of the urethra, it may form a subcutaneous tract, running parallel with the course of the urethra and opening just behind the glans. Or the fistulous tract may pass backward and open near the root of the penis.

Treatment.—The restoration of the normal calibre of the urethra anterior to the fistula is the first essential of treatment, and will often be curative.

If the fistula persists, regular evacuation of the bladder by means of a catheter should be continued for a week, the urethra receiving an antiseptic flushing (boric acid four per cent., or silver nitrate 1 to 10,000) after each passage of the instrument. If this fails, and if the fistula is direct and of small size, cauterization of the tract by the galvano-cautery may cure. This failing, the urethra should be thoroughly freed about the margins of the opening, and the borders of the latter having been freshened should be approximated by a row of catgut sutures (Fig. 99); another row of silk sutures is employed to bring together the skin and underlying fascia. The dilating speculum or urethral dilator greatly facilitates this operation. Undue tension on the sutures and contamination by urine may be prevented by regular catheterization, or still more surely by perineal urethrostomy, the bladder being drained through this opening till the fistula is permanently closed.

If the fistula is so large that closure by this operation would entail too great an encroachment on the urethral calibre, a plastic operation will be required. A transplanted flap is usually taken from the scrotum; or one from the prepuce or from the inguinal or abdominal region may be employed. When the flap is taken from the scrotum, a quadrilateral space about the fistulous

opening is freshened, a flap of similar shape, with its adherent base down, is raised from the scrotum, and its anterior and lateral borders are sutured to the freshened surfaces. In a week the pedicle is divided and secured to the posterior border of the defect. To secure success in these cases, regular catheterization or perineal urethrostomy is necessary.

Probably the most efficient way of closing these fistulæ is by the operation of double lateral flaps. A short flap is turned in, bringing the skin surface toward the urethra; then a long flap, from the opposite side, so freely dissected that it is subject to very little tension, is brought across by sutures, its raw surface being apposed to the raw surface of the inverted short flap.

URETHRAL POUCHES OR DIVERTICULA

In addition to the congenital pouches already described, there are observed sacculations at the expense of the urethral wall, due either to gradual yielding to vesical pressure or, more commonly, to ulceration and abscess-formation, or to both these causes combined. The predisposing factor is inflammation incident to stricture, especially when there is a calculus lodged behind the stricture.

Symptoms.—The symptoms are sufficiently characteristic. There is long-continued dribbling of urine after apparent complete evacuation of the bladder. Examination shows either a sacculation or a dilatation in the course of the urethra, which is distended during the course of micturition, and which on being compressed becomes flaccid, urine at the same time dribbling from the meatus. In some cases, when the pouch contains a calculus, the latter changes position during urination, acting as a valve. Usually there are no inflammatory phenomena, and the tumor is compressible and painless, thus differing from chronic urinary abscess. Urethroscopy is the most satisfactory diagnostic method.

Treatment.—Treatment consists in extracting the calculus, if there is one, either by intraurethral manipulations or by external incision. Strictures should be cured by gradual dilatation, or by urethrotomy, with perineal resection of the sac-walls if necessary. Simple diverticula behind the stricture are usually cured by wide dilatation. Exceptionally after cure of stricture the pouch must be resected and the opening into the urethra closed by suture.

URETHRAL NEOPLASMS

Papillomata (which the urethroscope has shown to be not so rare as was believed) appear as pedunculated or sessile, vascular, papillary outcroppings (Fig. 100); other neoplasms of less frequent occurrence are cysts, polyps, and carcinomata. They grow from any portion of the canal, but are commonly found in the navicular fossa and behind strictured portions of the urethra, syringing from the floor. They are usually small, but exceptionally may attain a size sufficient to obstruct very considerably the stream of urine.

When they develop near the meatus, and this is their commonest seat, they are prone to grow outward, projecting from the urethral orifice as a soft, easily bleeding, fungating mass.

Symptoms.—These are usually slight, and are mostly mistaken for those of gleet dependent upon stricture. There is a thin, muco-purulent discharge, with slight burning during urination, and, if the growth attains large size, interference

with the volume and force of the stream. Often there is free bleeding on instrumentation, particularly in cases characterized by comparatively large areas of sessile, highly vascular papillary hypertrophy. The diagnosis is founded on an intraurethral examination. The urethroscope shows these growths usually as slight villous projections, sometimes as raspberry-like masses, occasionally as gelatinous pyriform tumors.

Treatment.—This consists in removal of the growth by means of high-frequency desiccation, wire snare, curette, or galvanocautery, manipulated through an endoscopic tube. If the polyp is snared or scraped away, the place from which it was removed should be touched with glacial acetic acid or pure carbolic acid. This operation is not difficult when the growths, as is usually the case, are situated near the meatus. A dilating speculum in these cases is more serviceable than the closed tube.

Urethral caruncles are rare in the male urethra, but are occasionally found

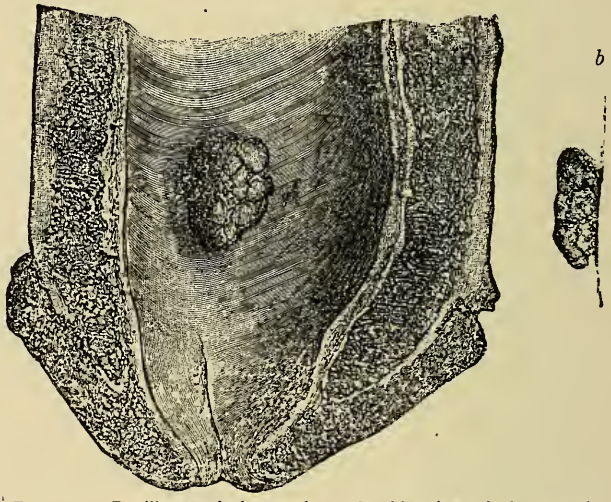


FIG. 100.—Papilloma of the urethra. *b*, side view of the growth. (Voillemier.)

near the orifice in the navicular fossa. They consist of small, bright, red, pedunculated, highly vascular, papillated tumors, made up of connective tissue, covered by stratified epithelium.

They are characterized by severe pain, aggravated by urination, and moderate mucopurulent, often blood-stained, discharge. The pain during sexual intercourse is so great as to be inhibitory. Instrumentation is intolerable.

They are distinguished from *irritable gonorrhœa* by the gradual onset, and by the absence of gonococci from the discharge. The urethroscope discloses the tumor.

The treatment consists in the complete removal of the little tumor—including its base—by means of small scissors, the wire ecraseur, or cautery knife. A meatus dilator will usually make the growth accessible, though a preliminary meatotomy may be needful.

Cancer of the Urethra.—Primary cancer of the urethra occurs in men over fifty years of age who have suffered from chronic urethritis due to stricture. It has been found only in the bulbous and membranous urethra. The growth invariably proceeds forward (Hall), showing no tendency to invade the prostate and the tissues behind the triangular ligament.

Symptoms.—The symptoms, during the early stage of infiltration, are simply those of chronic urethritis; later there may be increasing difficulty in urinating, obstruction to the passage of a catheter, and the formation of rapidly growing infiltrations, which, in the absence of previously existing fistula, soften in one or more spots and rupture, discharging pus, blood, and often very offensive urine. After rupture there is found a comparatively small cavity with hard, irregular walls tending to fungate in places.

Diagnosis.—The diagnosis is based upon the urethroscopic appearance, the dense infiltration, the progressive and rapid growth, and the removal and microscopical examination of a portion of the tumor. The tendency to bleed and fungate and enlargement of the inguinal lymphatics may possibly prove of diagnostic value.

Owing to delay in diagnosis few cases of cancer of the urethra have so far been saved. In the future earlier diagnosis through use of the urethroscope should produce a higher percentage of operative cures.

Cancer of Cowper's gland, which on first examination may suggest primary cancer of the urethra, may be distinguished from the latter by the fact that it has at first a tendency to grow towards the skin and rectum rather than in the direction of the urethra, forming a palpable perineal tumor, which, till it has reached a large size, does not interfere with the passage of a catheter or the free flow of the urine.

Treatment.—Immediate and complete removal of all the diseased parts and of the anatomically associated glands is indicated. Where this is not possible, irrigations, local washings, and morphine in sufficient doses to quiet the patient should be employed.

DISEASES OF COWPER'S GLANDS

On each side of the membranous urethra, between the two layers of the triangular ligament, is placed a pea-sized, lobulated, racemose gland, the duct of which, one inch long, perforates the anterior layer of the triangular ligament and empties into the bulbous urethra. These glands are sexual in function, and their secretion forms a part of the semen. Both they and their ducts, being lined by columnar epithelium, are readily susceptible to gonorrhœal invasion, and once having been infected remain fruitful sources of reinfection after an apparently cured urethritis. These structures cannot be reached by intra-urethral applications, nor are they amenable, because of their position, to massage. Chronic hypersecretion of Cowper's glands is a common source of intractable urethrorrhœa. As is the case with their homologues (Bartholin's glands), these structures are rarely infected by organisms other than the gonococcus.

Cowperitis.—Cowperitis, or inflammation of Cowper's gland, usually develops in the third or fourth week of an acute urethritis. It is due to an

extension of the disease from the bulbous urethra, into which the ducts of these glands empty. All the causes which tend to aggravate an attack of acute urethritis, such as sexual or alcoholic excesses or violent exercise, predispose to inflammation of Cowper's glands.

Symptoms.—The first symptom is a sticking pain in the perineum; this is greatly increased by pressure, so that sitting or walking markedly increases the suffering. The swelling of the glands is resisted by the two layers of the triangular ligament between which they are situated and by the deep perineal fascia: hence, as the inflammation progresses, great tension is developed.

Both micturition and defecation are painful, the suffering being particularly severe at the termination of the former act, since the transverse fibres of the compressor urethræ muscle, as they contract to expel the last drops of urine, compress the inflamed and swollen gland. If the swelling is very marked there will be some difficulty in micturition from mechanical pressure.

Usually but one gland is involved. It may then be felt as a small, hard, very tender tumor situated just behind the bulb,—that is, about the middle of the perineum. This tumor may be recognized by deep palpation of the perineum, or by pressure made in an upward and forward direction by a finger inserted just within the external sphincter. The fact that this swelling is on one side of the median line constitutes a distinct diagnostic point. When both glands are involved the swelling is bilateral.

Suppuration sometimes occurs. When this involves the periglandular tissues the skin will become reddened and œdematous, and the rigors, fever, and throbbing pains of pus-formation will be present. The swelling in these cases is nearly always sufficient to interfere materially with micturition, often causing complete retention. The abscess usually perforates externally, and on the discharge of a large quantity of pus heals kindly, although subsequently it may be followed by troublesome cicatricial contraction. In rare instances the abscess may perforate into the urethra, but even then extravasation of urine is exceptional. The inflammation frequently becomes chronic, lingering particularly in the gland ducts, and occasioning a discharge which is extremely hard to cure.

During the course of an acute cowperitis the discharge of the anterior urethritis usually ceases or is greatly diminished in quantity.

Diagnosis.—When the case is seen early the anatomical position of the firm nodule or nodules renders diagnosis easy; but when suppuration occurs, together with wide-spread periadenitis, it may be hard to determine the true nature of the inflammation.

It may be distinguished from a superficial perineal abscess by the fact that the latter cannot cause dysuria.

From urinary infiltration following stricture it can be distinguished only by the history of the case. Periurethral abscess of the bulb is farther forward than is the tumor in cowperitis, and is always in the median line.

Treatment.—Every effort should be made to lessen the urethral inflammation. Strong antiseptic or astringent injections or intraurethral manipulation must be discontinued at once. Rest in bed, prolonged hot baths, and the administration of a laxative or a saline purge are always indicated. A hot-

water bag applied to the perineum relieves pain and seems to lessen the tendency to abscess formation. When the suffering is intense, hypodermics of morphine are indicated.

When throbbing pain, œdema, flunctuation, and rigors and fever show that pus has formed, the abscess should be cut into at once, and its cavity curetted and packed with iodoform gauze. Urinary extravasation, of course, demands immediate incision and drainage. Fistulæ may be guarded against by permanent catheterization after the abscess has been opened and drained. When, in spite of every precaution, fistulæ form, and are not relieved by catheterization and free dilatation, excision of the fistulous tract, as well as of any remnant of the gland, and suture of the freshened edges, are required.

Cysts of Cowper's Glands.—These rare swellings project into the urethral lumen at the expense of its floor. If large, they may be detected by perineal or rectal palpation. In one case the tumor opened externally, discharging a viscid fluid at irregular intervals, but particularly during and after coitus.

Cancer of Cowper's Glands.—This rare growth, in the form of a cylindroma forms a hard, movable, distinct encapsulated nodule. As it grows it becomes adherent to the surrounding parts, and the involved inguinal glands. The growth, at first painless, rapidly increases in size and ultimately presses upon the urethra. Micturition becomes difficult, frequent, and sometimes painful. Defecation is interfered with, and sitting or walking increases suffering.

Diagnosis.—The characteristic feature of this affection is the position of the tumor. It is placed upon the bulb, is at first covered with healthy skin, and grows rapidly. Combined rectal and perineal examination shows it to be in the position which normally should be occupied by Cowper's glands.

Treatment.—Complete early removal. A timely diagnosis is rarely made. These patients die within the year, though there is one recorded case of survival without recurrence for nearly two years.

CHAPTER X

AFFECTIONS CHARACTERIZED BY URETHRAL DISCHARGE

In accordance with their etiology, affections characterized by urethral discharge may be classified as follows:

1. Urethrorrhœa. Entirely independent of local lesions.

2. Traumatic urethritis, due to (*a*) Instrumentation (*b*) Irritating injections, (*c*) External traumatism.

3. Irritative urethritis. (*a*) Ingestive, due to certain drugs and articles of food; (*b*) Diathetic, dependent upon irritating conditions of the urine incident to defective metabolism; gouty, rheumatic, oxaluric, and phosphaturic urethritis; (*c*) Erethismic, due to repeated excessive coitus or prolonged ungratified sexual excitement.

4. Eruptive urethritis occurs during the course of certain acute exanthemata, and as a manifestation of urethral herpes or eczema.

5. Mechanical urethritis, incident to (*a*) stricture, (*b*) urethral neoplasms, (*c*) urinary calculi, (*d*) animal parasites (rarely, in children).

6. Concomitant urethritis, dependent upon disease of para- and periurethral structures.

7. Infective urethritis.—(*a*) Simple pyogenic, sometimes called irritative or abortive gonorrhœa; (*b*) Gonococcal; (*c*) Syphilitic (primary, secondary, tertiary); (*d*) Chancroidal; (*e*) Tuberculous; (*f*) Typhoidal; (*g*) Influenzal; (*h*) Pneumococcic; (*i*) Diphtheritic.

Urethrorrhœa is due to depraved constitutional conditions, and occurs independently of local lesions. It is observed during convalescence from acute, exhausting diseases, such as typhoid fever, scarlet fever, pneumonia, influenza, small-pox, and the like; or in the course of such chronic affections as tuberculosis, cancer, syphilis, advanced nephritis, neurasthenia, anæmia, and other debilitating cachectic conditions. The discharge is dependent upon a relaxed and leaky mucous membrane, and represents an excessive quantity of what is in character a normal secretion. This constitutes the sole symptom, appearing as a colorless viscid material not unlike glycerin. In the urine it forms long shreds.

Diagnosis.—This depends on the history, the general physical examination, and the elimination of other causes such as catheterization, etc. Microscopic examination of the discharge shows mucus epithelial cells, a few leucocytes, and a variety of bacteria normally present. Spermatozoa are often found.

Treatment should be entirely constitutional. Incidentally, the urine should be kept unirritating. Local congestion, such as would be caused by sexual excitement, stripping the urethra, and irritating injections must be avoided. Internally, cubebs may be serviceable.

URETHRITIS

Etiology.—The predisposing causes of urethritis are congestion and impaired local vitality. With the more potent exciting causes it is not essential that any predisposing cause should be present.

The exciting cause of urethritis is infection, usually by the gonococcus.

Pathology.—This is similar to that of inflammation of other mucous canals, with certain differences incident to the anatomy and physiology of the urethra, its susceptibility to certain varieties of microbic invasion, and its accessibility to local treatment.

The inflammation common to all forms of the acute disease usually begins at or near the meatus and spreads backward. The mucosa of the canal and of its many follicles and lacunæ becomes infiltrated, red, swollen, covered with a mucoid, sanious, or purulent exudate, and soon the epithelium exfoliates. In the milder cases the process is limited to the mucosa, and after a few days or weeks subsides, but may persist in the follicles and glands for weeks and months.

The gonococcus penetrates deeply into the submucous tissue, causing abundant round-cell infiltration, nests of which may be the beginning of periurethral abscess. The process may involve any or all of the structures opening into the urethra, including the upper urinary tract. Lymphangitis and lymphadenitis are common; phlebitis and cellulitis are rare.

Urethroscopic examination of acute diffuse urethritis shows redness, swelling, and exfoliation of the mucous membrane, and muco-purulent exudation.

Symptomatology.—Discharge is the only constant symptom. It may be manifest only in the urine; it may appear as a slight moisture at the meatus, not noticed unless the intervals between urination are long, or as a drop after stripping the urethra, or during a straining effort at defecation. In acute cases it may appear as a profuse, continuous outpour.

In character, it may be thin and watery, viscid, gelatinous, and stringy, resembling the uncooked white of egg, milk-and-watery in appearance, or may be made up of a thick, yellowish, greenish sanguino-purulent material. It may be noted in the form of crusts where it has dried around the meatus, or as stains on the underclothing. It may be without odor, or extremely foul.

The urine may be cloudy, or quite opaque, depending on the amount of mucus, pus, and blood contained in it; or may exhibit various forms of urethral shreds, from the irregular, short, thick, scaly, tack, or comma-shaped particles, to long, translucent, branching, gelatinous threads.

Pain may vary from the slighest itching, tickling, or burning sensation at the meatus to constant harassing distress throughout the whole of the canal. It may be referred to the glans, the penis, the deep perineum, or may radiate down the thighs.

Alterations of function vary from slightly frequent urination to annoying urgency, associated with painful vesical and rectal tenesmus. Tenderness is manifested by burning upon urination, aching during erection, or a stabbing, cutting anguish during seminal emission. Persistent, painful erections, with nocturnal pollutions, and chordee, may occur; rarely acute retention develops

from reflex or voluntary inhibition of the detrusors or contraction of the sphincter.

The objective signs may be absent; or they may appear as a simple florid puffiness of the lips of the meatus, or may be conspicuous in the form of inflammatory œdema of the glans, the prepuce, and rarely the subcutaneous tissue, with accompanying bubo.

The mechanical disturbances dependent on the swelling vary; there may be slight difficulty in starting the stream, loss of force or diminution of the normal parabolic curve, or dribbling after the act. Swelling or gluing of the lips of the meatus may break or deflect the stream.

Traumatic urethritis is usually due to instrumentation or to irritating injections. It may be caused by external traumatism.

Instrumentation always causes more or less traumatism, varying in degree from slight contusion to laceration, puncture, or even rupture of the urethra.

Irritating injections causing urethritis (of silver, mercury, phenol, etc.) will usually have been used to prevent or abort gonorrhœa.

The symptoms are commensurate to the severity of the trauma. Those of the hyperacute type developing immediately and characterized by great pain, rapid swelling, agonizing ardor urinæ, or even retention of urine and a scanty discharge of bloody pus are practically always due to irritating injections. Prolonged or brutal catheterization may cause an intense, frankly purulent inflammation, but of comparatively slow development.

External traumatism can produce urethritis only by first causing a sanguineous effusion into the urethra and in the periurethral tissues as a result of partial or complete rupture of the canal. (See page 158.)

Prognosis.—Urethritis due to irritating injections is at times distressingly persistent (years), and may lead ultimately to stricture formation. Generally the symptoms disappear promptly.

Treatment.—Instrumentation urethritis may be best avoided by the skilful use of clean instruments, preceded by cleansing the glans and by antiseptic urethral flushings. For the avoidance of the urethritis incident to continuous catheterization, see page 74. During the acute course of an injection urethritis, in addition to rest in bed, hot sitz-baths, diluents by the mouth, and opium suppositories, urethral injections of eucaine and adrenalin together with evaporating lotions applied to the penis may be needed to relieve retention of urine due to inflammatory swelling. Urethritis from external traumatism should be treated by irrigation and later by dilatation.

Irritative Urethritis.—Under this heading are included Ingestive, Diathetic, and Erethismic Urethritis.

Ingestive urethritis, characterized by scanty mucoid discharge and slight ardor urinæ, is occasionally noted after the ingestion of such substances as asparagus, rhubarb, turpentine, cubebs, copaiba, cantharides, alcohol, arsenic, and potassium iodide.

Diagnosis.—This is based on the history, and on the absence of other causes for urethral discharge. The symptoms are mild, the duration of the affection brief, and cure results at once upon removal of the cause. Ardor urinæ may be more marked than the inflammatory symptoms would seem to warrant. The

discharge which follows the abuse of alcohol is not strictly ingestive, but is usually due to the lighting up of a latent lesion by the irritating condition of the urine. When the symptoms are unduly prolonged, a search should be made for such lesions.

Diathetic urethritis is dependent upon the irritating urine incident to gout, rheumatism, and the defective metabolism characterized by the habitual appearance of large quantities of oxalates and phosphates in the urine. The relation between the joint manifestations of rheumatism and gout and a slight mucoid urethral discharge has been repeatedly noted; indeed, this discharge has been observed occasionally as a manifestation of so-called retrocedent gout.

Diagnosis.—This must be based on the history. The discharge is associated with general diatetic errors rather than with the ingestion of one or two particular articles of food. Other manifestations of gout or rheumatism are present and the acid urine is highly concentrated. The discharge is mucoid in character, with an abundance of epithelial cells, a few leucocytes, and no gonococci.

Prognosis.—In the absence of complicating gonorrhœal lesions, the urethral catarrh disappears when the constitutional condition is bettered and the urine rendered bland.

Treatment is obvious. Local treatment is not indicated. If, however, the discharge persists, search should be made for localized lesions.

Oxaluria and phosphaturia of themselves rarely cause urethral discharge, though they make quite incurable one which was originally started as a gonorrhœal infection. The persistence of oxalates or phosphates in the urine, accompanied by a mucoid or muco-purulent discharge neither gonococcal nor tuberculous in nature and unassociated with urethral stricture, polyp, or other localized lesion, would justify the suspicion that the discharge is dependent on the pathologic condition of the urine.

Erethismic Urethritis.—The discharge resulting from sexual excesses or prolonged ungratified sexual excitement is mucoid in character. It may be exceedingly persistent and usually indicates a urethra especially susceptible to bacterial infection.

Treatment.—This is mainly systemic. Bromides are very exceptionally of service. Hyoscine hydrobromate, grain $^1/_{200}$, twice daily, is useful when the discharge is due to prolonged ungratified sexual excitement. For this condition the psychrophore is also serviceable at times. As a rule, local treatment is contraindicated. Exercise, hydrotherapy, occupation, and diet usually suffice to effect a cure.

ERUPTIVE URETHRITIS is often overlooked. It is due to an active hyperæmia, with perhaps an accompanying eruption on the mucous membrane. Doubtless the irritating condition of the urine is a contributing factor. The appearance of slight urethral discharge coincident with the development of the skin or mucous membrane lesions of the fever, the elimination of other sufficient causes for such a discharge, and the disappearance of the latter with the betterment of the constitutional condition, would indicate the diagnosis. No local treatment is needed.

Herpetic urethritis is characterized by a sudden, apparently causeless, slight discharge commonly accompanied by severe neuralgic or burning pain

greatly exaggerated during micturition, preceded, followed by, or alternating with external herpetic lesions. There are no gonococci and there is no involvement of the posterior urethra.

Mechanical Urethritis.—A persistent urethral discharge in a healthy man, whose urine is normal and who leads a fairly healthful life, should always suggest the likelihood of a localized urethral lesion, and should lead to an examination for stricture, ulcer, chronic folliculitis, or urethral polyp. If the discharge has been preceded by a sudden, complete, or partial stoppage of the urine in the absence of a history of previous urethral inflammation the lodgement of a calculus should be suspected (see p. 164).

Concomitant Urethritis.—The peri- and para-urethral affections causative of urethra discharge include: Folliculitis, Cowperitis, Prostatitis, Vasitis, Seminal vesiculitis and Cystitis.

The usual cause of the extra-urethral affections which keep up the discharge is gonorrhœa. The history ordinarily shows this to have been present. Before its continuance can be eliminated, it will be necessary to make frequently repeated, painstaking examinations of the urethral discharge, the urine, and the semen for gonococci, microscopically (by the Gram method) and sometimes culturally. When there is no history of gonorrhœa, persistent urethral discharge secondary to infection of the prostate, seminal vesicles, vas, or bladder should lead to careful examination for tuberculosis.

Even though a urethral discharge be found associated with an extraurethral affection, its dependence upon the latter cannot be assumed till all other causative factors, and particularly stricture formation, have been eliminated. Concomitant urethritides are examples of infective urethritis, but are given separate consideration because of the influence of the underlying lesion on the treatment of the condition.

Infective Urethritis.—Simple purulent inflammation develops after unclean sexual intercourse or unclean instrumentation, particularly in those who from sexual excess, alcoholic indulgence, or previous attacks of urethritis are especially vulnerable. The exciting cause may be any form of pyogenic organism, the *Micrococcus catarrhalis* more often than any other than the gonococcus. This bacterium, similar in morphology and staining reactions to the gonococcus, though less uniformly found within the pus-cells, can be differentiated from the latter organism with absolute certainty only by biological methods. The urethritis produced is of a mild type, and usually runs a brief course without complications, though it may be quite persistent.

Symptoms.—These vary greatly. For the mild cases the following is descriptive: The usual cause is coitus with a woman suffering from leucorrhœa. It is characterized by a varying period of incubation, usually very short, at most one or two days, by a reddened, swollen itching meatus, by some pain on urination, and by a milky secretion from the urethra, appearing only when this canal is stripped forward. These symptoms are, of course, identical with those of the earliest stage of acute gonorrhœa, and, except by microscopical examination of the discharge, this form of disease cannot be distinguished from true gonorrhœa. Its course, however, is different. Unless the inflammation is treated by irritants, the symptoms do not increase in severity. Neither ardor

urinæ nor chordee develops. The discharge continues for five to ten days and then ceases spontaneously. There are no sequelæ and no complications. The condition is a purely catarrhal one. The disease subsides, under almost any treatment which is not too violent, in a time which is very short as compared with the duration of ordinary gonorrhœa. The attendant is often, and not unnaturally, led to believe that such subsidence is due rather to his treatment than to the spontaneous cessation of the disorder.

The account just given represents the usual course of a simple infectious urethritis. Exceptionally the inflammation is as violent and prolonged as if from gonococcus infection. In strumous and cachectic individuals the discharge may remain slight, but persists for weeks, months, or years, in spite of treatment, and commonly brings about a marked condition of sexual neurasthenia.

Gonorrhœal Urethritis.—This, the commonest variety of urethritis, and the one most often exhibiting complications, is considered in a separate section (see p. 183).

Syphilitic Urethritis.—A urethral discharge may be due to primary, secondary or tertiary syphilis. Urethral chancre, usually placed within half an inch of the meatus, is often not recognized as such till a secondary general eruption has clearly indicated the nature of the affection; yet in the absence of a mixed infection the diagnosis should be suggested by a urethral discharge with an incubation period longer than ten days, induration, inflammatory infiltration of the frænum, typical bilateral inguinal adenitis, and the detection of urethral ulcer covered by a grayish pseudo-membrane.

The diagnosis from gonorrhœa is made by the longer incubation, usually three weeks, by the presence of induration in the urethral wall near the meatus, as determined by palpation, and of an ulcer in this location, revealed by speculum or urethroscope, by the general absence of inflammatory symptoms, particularly of ardor urinæ and painful erections; by the more serous, gonococcus-free discharge, and the presence of *Spirochætæ pallidæ* in scrapings from the ulcer. In the case of chancre the Wassermann is usually positive after the second week.

The urethral chancroid is acutely inflamed, discharges freely, and forms a punched-out, ragged, nonindurated, spreading ulcer, from the exudate of which the Ducrey bacillus may be recovered.

A persistent mucoid or mucopurulent discharge also characterizes secondary and tertiary syphilitic lesions, which are found in the urethra as areas of congestion, mucous patches, or relapsing gummatous ulcerations. Unless there be a double infection gonococci will not be found. Urethroscopic examination shows areas of non-indurated exfoliation, erosion, or ulceration, usually near the meatus. The inflammatory symptoms are mild as compared to gonorrhœal, herpetic, and eczematous eruptions; and in the pure syphilitic infection there are no symptoms referable to the posterior urethra.

Treatment.—This is that appropriate to syphilis. Local treatment is rarely needed except for the cicatricial contracture following gumma.

Chancroidal urethritis begins at the meatus and extends backward. The period of incubation is variable (one to four days or longer). The Ducrey bacilli and abundant staphylococci and other pyogenic organisms are found in the

purulent, often blood-stained, secretions, but, unless double infection has occured, no gonococci; not infrequently similar lesions are noted on other parts of the genital organs. Absence of induration is the rule. Inguinal buboes are common.

The subjective symptoms are mild compared with the profuseness of the discharge. In the absence of mixed infection there are no deep-seated complications. Unlike chancre, which may be entirely intraurethral, the ulceration of chancroid either develops on the lips of the meatus or shortly appears there, making the detection of its presence easy. Urethral chancroids are occasionally followed by fistulæ, and, as a rule, by stricture, unless this be guarded against in the course of healing.

Treatment.—This is conducted in accordance with the principles laid down in the treatment of chancroid (see p. 123). Stricture must be guarded against by the use of a meatus bougie during the process of healing.

Tuberculous Urethritis.—Till recently believed to be a most uncommon lesion, Pelouze [1] has shown tuberculous lesions of the posterior urethra to be of fairly frequent occurrence. A chronic urethral discharge was present in all of his cases, while the majority of them complained of an intense burning pain in the fossa navicularis during urination; a smaller number of pain at the neck of the bladder. The lesions found consisted of lymphoid-like masses, from one to three millimetres across on the lateral walls of the posterior urethra. In a postmortem specimen these were found to be surrounded by an area of inflammatory reaction; through the posterior urethroscope they appeared paler than the urethral mucosa about them, distinctly watery. Tubercle bacilli were found in the urine of the majority of the cases.

Others have reported the occurrence of ulcerations and cheesy infiltrations, chiefly in the posterior urethra, but also in the anterior portion of the canal.

Symptoms.—The symptoms of urethral tuberculosis are a chronic urethral discharge, and, when the disease affects the posterior urethra, frequency of urination, tenesmus, pain, and often blood at the end of urination. Lesions of the anterior urethra usually excite no symptoms other than a slight mucopurulent discharge. Injection of silver nitrate ordinarily occasions a violent reaction and is followed by severe pain which may persist for weeks or months.

Diagnosis.—The diagnosis of urethral tuberculosis is founded on the discovery of the tubercle bacillus, the association of the lesions with evidence of tuberculous infection in other parts of the body, particularly in the genital tract and in the lungs, and urethroscopic examination. An apparently causeless purulent urethral discharge should always suggest a careful search for tubercle bacilli.

Treatment.—The treatment is dependent upon the extent and multiplicity of lesions other than those found in the urethra. When the urethral infiltration is simply a part of a general infection, irrigation, and instillation of bichloride solution 1 to 6000 once daily, and the use of iodoform bougies ten per cent. in cacao butter or gelatin, or of iodoform insufflated through the tube of an endoscope, represent as active local treatment as is serviceable. A single or

[1] *American Journal of Urology*, 1917.

limited infiltration should, in the absence of lesions elsewhere, be thoroughly curetted or removed by an external urethrotomy, the urethra being resected and subsequently sutured should complete removal require this. Tuberculin therapy is a useful adjuvant.

Typhoidal Urethritis.—The urethral inflammation sometimes accompanying typhoid fever is probably dependent upon congestion induced by the concentrated febrile urine, which in turn favors infection by the *bacillus coli communis* and other pyogenic bacteria. The discharge is mucopurulent in character, rarely profuse, contains abundant pyogenic bacilli, pus-cells, mucus, and epithelium without gonococci. There is always accompanying cystitis.

Prognosis.—During or immediately following the appearance of typhoidal urethritis, but generally later in the course of the fever, there may develop epididymoörchitis. The latter, however, is generally a pure typhoid infection occurring through the blood (see p. 324). The urethral discharge promptly disappears as convalescence progresses.

Treatment.—The urine should be rendered bland. Urinary antiseptics are indicated.

Influenzal urethritis is also due to pyogenic infection, and its relation to influenza is coincident.

Pneumococcic and diphtheric urethritis are more truly specific, since in these forms the specific bacteria may be abundant and there is (in the diphtheritic) membrane formation.

Symptoms.—These are severe, the discharge profuse, purulent, and blood-stained. There may be shreds of membrane exfoliated. Constitutional symptoms, fever, etc., coexist. Yet rarely does the process extend further than the anterior urethra. The pneumococcic is far less severe than the diphtheritic.

Diagnosis depends on the bacteriologic examination, since false membranes may form in other varieties of severe urethritis.

Prognosis is favorable, the disease being usually short in duration.

Treatment should be constitutional and local. Antitoxin should be employed against diphtheria. Locally, mild antiseptic irrigations are indicated.

GONORRHŒA

Gonorrhœa is a contagious specific inflammation of the mucous membranes of the genito-urinary tract. It also affects the conjunctiva and the mucous membranes of the rectum and mouth.

Etiology.—Gonorrhœa depends for its development upon the presence of a specific microbe termed the gonococcus. It usually runs a somewhat typical course—one longer and attended with more complications than nongonococcal urethritis.

The gonococcus when cultivated on a suitable medium shows a very small, scarcely perceptible grayish surface, appearing shiny, moist, and slightly yellowish by reflected light. The development of this culture is slow, and the growth never extends widely, reaching its uttermost dimensions in two or three days,

after which time the germs lose their virulence, and shortly can no longer be transplanted with successful results. The growth is always on the surface. It is inhibited by extremely weak antiseptic solutions.

Gonococci grow best at a temperature of 36° C. The best medium for routine use is prepared by adding five drops of rabbit-blood to eight or ten cubic centimetres of ordinary nutrient agar, 1 per cent. acid to phenolphthalein. The blood should be allowed to drop from the opened vein in the ear of a rabbit directly into the agar, which has been melted and cooled to a temperature between 40° and 55° C. The blood is distributed through the agar by rolling the tube between the palms, and the tube is slanted. This medium has been found to combine the advantages of reliability and ease of preparation. Even on it a growth is not invariably obtained, especially when the pus has been taken from a chronic case, so that a negative result cannot be taken to prove the absence of the organisms.

The gonococcus is distinguished by its shape, grouping, position, color reaction, and growth on artificial media.

In shape the gonococci resemble the two seeds of a coffee-bean,—that is, they are diplococci, flat or slightly concave on one side, and rounded on the other, with their flat (Plates II and III) surfaces apposed. In the process of multiplication each half of the diplococcus divides at right angles to the fissure between the two. Hence the gonococci are always grouped in irregularly shaped colonies; chains are never found. They quickly take the stain of ordinary basic staining reagents, such as fuchsin, methyl or gentian violet, or methylene blue, and are readily decolorized by the Gram method, this fact serving to distinguish them from other urethral cocci, except the *Micrococcus catarrhalis.* (For the methods of staining pus see Chapter II, page 19.)

If Gram-negative characteristic *biscuit-shaped diplococci,* arranged in *pairs, fours,* and other *multiples of two,* showing a tendency to *rectangular disposition,* and located *within* the cellular elements are discovered in urethral pus the diagnosis of gonorrhœal urethritis is sufficiently positive for all clinical purposes. If, however, negative results are obtained—*i.e.,* if gonococci are not found—we cannot be absolutely sure the patient has not gonorrhœa.

In medico-legal cases or in cases involving a question of chastity or of family relations, repeated examinations may be required and the concurrent circumstances should be given full weight in reaching a conclusion. The obtaining of cultures of the gonococcus is conclusive evidence, but inability to obtain a growth cannot be given similar consideration. The complement fixation test is of greater utility.

Failure to find the organisms may be incident to faulty technique or to imperfectly prepared reagents. The organisms may be so deeply situated in the submucous tissue or the paraurethral glands that they are found in the discharge only when it has been aggravated. Hence it is helpful to make the examination the morning after a night of dissipation or a dinner of highly irritating food, or a horseback or bicycle ride, or to set up a more or less acute superficial inflammation by instrumentation or irritating injection, or to examine

the discharge expressed by massage of the prostate, seminal vesicles, and Cowper's glands.

The important characteristics of gonococci may be summarized as follows: they are diplococci; they appear in heaps, which nearly always occupy the protoplasm of cells; they are very numerous in acute cases; they are readily colored by aniline dyes and decolorized by Gram's method of staining; they are nonpathogenic to lower animals.

Character of the Discharge.—From a microscopic standpoint, gonorrhœal discharges consist of an albuminous fluid in which are distributed mucus, pus-cells, epithelial cells, and bacteria in greatly varying proportions. In the early hours of the discharge the number of epithelial cells is comparatively large, and that of the pus-cells comparatively small; gonococci are not plentiful, and in the main are located without the cells. The epithelial cells are small in size, and contain large, deeply-staining nuclei.

During the height of the attack the pus-cells are the most prominent constituent. Gonococci are present in enormous numbers, the great majority of them lying within the bodies of pus-cells. The number of epithelial cells is small, both relatively and absolutely. A small amount of mucus is present.

During the declining stages of a gonorrhœa a constantly increasing amount of mucus is seen, and the number of pus-cells becomes correspondingly diminished. However, it is impossible to describe a single condition as typical of this stage, for the picture is a changing one. Thus, in the same patient the lapse of a few days during which there have been indiscretions in diet, etc., may cause a discharge which had been of a distinctly mucoid character to assume the characteristics of the exudate of the acute form of the disease. In the main, however, there is a decrease in the pus-cells and gonococci, and an increase of mucus, epithelial cells, and contaminating bacteria. The epithelial cells are generally larger than those seen in the early stages of the disease, and have much smaller nuclei.

Gonorrhœal shreds are classed clinically as mucoid, mucopurulent, or purulent, the different groups being differentiated by their relative buoyancy, the mucoid shreds floating near the surface of the freshly voided urine, whereas those containing a large amount of pus sink rapidly to the bottom. From a microscopic standpoint, shreds consist of an albuminous matrix in which are embedded pus-cells, epithelial cells, and small numbers of bacteria. It is very unusual to see a shred which is entirely free from pus-cells, and consisting only of mucus, or of mucoid material and epithelial cells.

Shreds are most easily transferred to the slide or cover-glass by means of a pipette, or by floating them on the submerged glass, the urine being removed from about the specimen with filter-paper.

Source of Discharge.—Pus formed in the anterior urethra tends to flow forward and appear at the meatus; pus from the posterior part of the canal makes its way backward into the bladder. (For reasons for this distribution and methods of determining the origin of pus see page 14.)

Pathogenesis and Pathology.—Gonococci, deposited on the mucosa of the urethra, lie upon its surface for from six to twelve hours. At the end of this time they pass through the mucosa, chiefly through the intercellular substance,

penetrating to the papillary layer, and in the neighborhood of the urethral glands, invading the submucosal connective tissue. The epithelia of the follicles and of the ducts of the glands become infected along with the surface mucosa, but the secreting epithelium of the glands escapes.

Sections of the mucosa show it to be the seat of cloudy swelling and round-cell infiltration, with desquamation of the superficial cells. The pathological changes are most marked in the neighborhood of the glands and follicles, the intervening smooth mucosa being comparatively normal. In the later stages of urethritis the mucosa becomes changed from a simple columnar epithelium to a stratified structure with large squamous cells on its surface. At this time there is also a development of fibrous tissue, which by the contraction characteristic of this substance lessens the calibre of the urethra and obliterates the glands and their ducts.

The rôle of the gonococci in the later stages of the disease is not clear, but it seems probable that they lie in the deeper portions of the mucosa during the periods of remission of symptoms, being carried to the surface in the bodies of the leucocytes, with consequent fissuring of this membrane, at times of exacerbations of the disease.

TYPICAL ACUTE GONORRHŒA OF THE MALE URETHRA

This form of urethral inflammation is due to infection of the urethra with the gonococcus. Such infection is nearly always due to sexual intercourse, the virulent pus from the female entering the male urethra to a greater or less depth. This method of acquiring the disease is termed immediate contagion.

The disease also may be conveyed by mediate contagion,—that is, through the medium of clothing or other articles containing the specific microörganisms. Since to excite inflammation the microörganisms must gain access to the urethra, it can readily be seen that mediate contagion, excepting by the agency of bodies introduced within the urethra, must be exceedingly rare.

Gonorrhœa of the male urethra, in accordance with its clinical course, may be mild, subacute or catarrhal, severe, neurotic or neuralgic, recurrent or relapsing, or intractable.

Mild gonorrhœa is characterized by long incubation, moderate symptoms, absence of complications, and at times rapid cure, though the disease may be indefinitely prolonged. Treatment, both local and hygienic, should be carried out faithfully as would be indicated for a more severe attack.

Subacute or Catarrhal Gonorrhœa.—This occurs most frequently in persons who have suffered from a previous attack of gonorrhœa, and exemplifies the tendency manifested by the mucous structures to become readily excited to inflammation from slight causes after having been once affected. This is particularly noticeable in the urethra, because this canal affords periodical passage for the urine, which, from changes in its constitution, may become an irritant. During erection it is exposed to intense congestion. On account of its free blood-supply and of the absence of firm extravascular support, the blood-vessels remain in an atonic condition and become greatly congested on slight provocation long after apparent complete recovery from an attack of urethritis.

The close apposition of the mucous surfaces except during micturition also favors the continuance of granular or congested areas or other traces of inflammation; hence but few who have had one attack of gonorrhœa escape subsequent manifestations, infection too feeble to overcome the resistance of a healthy urethra finding under such circumstances favorable soil.

Symptoms.—In this form of gonorrhœa the incubation period is exceedingly variable (one to ten days), and there is often no inflammatory symptom beyond a profuse mucopurulent urethral discharge. There may be a slight feeling of warmth during urination and some increased sexual excitability, but ardor urinæ and painful erections are usually absent. A pure pus discharge is very rare, the latter being mainly mucous or serous. Gonococci and pus-cells are not abundant, but are found, together with epithelial cells, principally of the flat and transitional variety. The inflammation seems to be purely superficial in its nature, and the disease is rarely attended by local complications. This form of discharge should be differentiated from that due to urethral syphilis (see p. 181).

Under treatment the discharge rapidly diminishes in quantity until only a drop of mucus is found in the morning; but this symptom is liable to persist for a long period, and is exceedingly difficult to suppress.

Severe or virulent gonorrhœa occurs in those whose urethras are predisposed to inflammation by intense congestion, such as results from alcoholic and venereal excesses. It is also observed in healthy young men, who have never had a similar infection and who have practised ill-advised, irritating injections in the hope of preventing gonococcal infection.

The period of incubation is short, the subjective symptoms are severe. The discharge is profuse and bloody, marked posterior urethral involvement occurs early. Blood-stained pollutions, ardor urinæ, often retention of urine, painful erections and chordee, harass the patient, who is still further weakened by fever due to septic absorption. Complications are common and troublesome. The course of the disease is usually prolonged. Treatment should be active, and stringent to the minutest detail. Rest in bed, diluents, a milk and butter-milk diet, hot sitz-baths, and regular evacuations from the bowels are means best calculated to prevent complications and to hasten cure.

Neurotic (or neuralgic) gonorrhœa is characterized by hyperacute subjective symptoms, out of proportion to the amount of discharge. The irritable cases show excessive local pain. Injections and irrigations are intolerable, and often cause bleeding. Erections and chordee are frequent. Local tenderness is severe. For these cases full doses of bromide are indicated. Hyoscine hydrobromate, grain $^1/_{100}$, or hyoscyamine sulphate, grain $^1/_{100}$, at bedtime will relieve the chordee. Hygienic, dietetic, and internal medical treatment must be stringent. Drugs stimulating to the mucous membrane, such as copaiba, and cubebs, must be omitted. Local injections and irrigations are contra-indicated until the subsiding stage.

Neurotic or neuralgic gonorrhœa is often associated with neurasthenia or even melancholia; there is a distrust of treatment and impatience at the slowness of results, with a tendency to try secretly every suggestion, independent of its source. The discharge and local symptoms may be mild, but the dis-

ease tends to become intractable as a result of diversified treatment. Due consideration to the neurasthenic element should be given in the management of these cases.

Relapsing and recurrent gonorrhœa, if not due to reinfection, is usually incident to an almost symptomless chronic posterior urethritis. Exceptionally, a gonorrhœal cowperitis or folliculitis is the cause. The treatment consists in finding and ablating the focus of the recurring urethral infection.

Intractable gonorrhœa is always due to a persistent lesion, usually a folliculitis associated after months and years with stricture formation. As a rule, it is observed in persons impatient of restraint, who before complete cure of an acute case revert to the excesses which were responsible for the original attack. The treatment of these cases is dependent on finding and eliminating the local lesion. A very small percentage of these cases are tuberculous.

Incubation.—There is always an interval of time between exposure to contagion and the development of noticeable urethral symptoms. During this time the germs are multiplying, and a focus of inflammation is becoming established sufficiently extensive and intense to excite attention. This time varies between a few hours and two or three weeks, since it depends upon the original strength of the microbic invasion, the seat of entrance, and the vital resistance of the mucous membrane. An extremely short incubation period or one which is unusually long should always lead the surgeon to doubt the gonorrhœal nature of the urethritis till this is determined by microscopic examination. Three to five days represent the ordinary incubation period,—that is, the time elapsing between exposure to the disease and the development of the first symptom.

Prodromal Symptoms.—Often the first symptom of a developing urethritis is a constantly recurring tendency to fix the attention on the penis. Even though the parts seem perfectly normal, there is a strong desire to subject them to frequent inspection.

A sense of heat and itching in the glans, slight fugitive tickling sensations at the meatus, together with a feeling of weight and tension in the penis and a tendency to develop erection on the slightest excitement, are most frequently noticed.

Inflammatory Symptoms.—In twenty-four hours symptoms of inflammation become more pronounced; there are now developed (1) swelling of the meatus and (2) discharge, becoming more and more marked from day to day, and shortly supplemented by (3) ardor urinæ and (4) sometimes painful erections, later by (5) frequent urination and vesical tenesmus.

Inflammatory Swelling.—1. The lips of the meatus are swollen and œdematous, often everted. The swelling may be so great that the urine can be passed only in a slow stream. Usually the stream is forked and irregular.

In severe cases the glans becomes gorged with blood, and the foreskin may be swollen, reddened, and œdematous. Enlarged lymphatic vessels may be felt passing as hard cords from the frænum to the back of the penis.

The urethra swells and becomes tender on pressure. It is at times nodular, owing to involvement of the glands and follicles.

2. The discharge, at first scanty and of milk-and-water color, turns to

a greenish yellow, and may be mixed with blood from the congested mucous membrane. It varies in quantity in accordance with the extent and violence of the inflammation, increasing till the disease has reached its acme. Finally the pus entirely disappears, usually leaving for days or weeks an oversecretion of mucus, which appears in the urine as long, irregular, translucent shreds.

3. **Ardor urinæ**, or pain during urination, becomes well marked within the first few days. The pain is commonly referred to the meatus or to the navicular fossa. It is often felt, however, along the entire anterior urethra, and may be reflected to the anal region. This pain is caused mainly by the action of acid urine on the inflamed mucous membrane, as is shown by the soothing effect of alkaline diuretics.

Not only is there burning on urination, but from slight mechanical disturbance, or even without obvious cause, sharp, cutting, stabbing pains are felt along the course of the pendulous urethra at various times. These may be so constant and annoying as to prevent all but absolutely necessary movements.

4. **Painful Erection.**—Even in the period of incubation there is usually increased sexual excitement, manifested by frequent and long-continued erections and even by increased pleasure in copulation. As the inflammation becomes more intense and widespread the erections become more persistent and are accompanied by pain which is often so severe that it constitutes one of the most harassing symptoms of the disorder. This pain is due to the fact that the congested infiltrated mucous membrane and submucous connective tissue is not able to stretch as it normally does when the cavernous bodies become engorged with blood. The tension upon the now nonelastic urethra is still further increased by a clonic contraction of the ischiocavernous and bulbocavernous muscles, which swing the penis upward against the abdominal walls.

Painful erection is present to a greater or less extent in all cases. It occurs most frequently during the sleeping hours, though it may give trouble at any time, day or night. The pain is felt mainly along the under surface or on the sides of the penis, and by its persistence either awakens the patient or keeps him awake.

When inflammation is unusually severe, chordee develops—that is, during erection the penis is curved or bent, usually downward, though lateral or upward curving is sometimes observed. In these cases the pain is generally severer than when there is no such deformity. The bending of the organ is due to the inflammatory infiltration of one or more of the erectile bodies, complete engorgement being thereby prevented. The bending is toward the body or bodies most affected by the inflammation.

Complete or partial rupture of the urethra is the usual result of violent attempts to straighten the penis, breaking a chordee, as it is called, sometimes indulged in by patients driven to exasperation by the tormenting pain of the condition.

5. **Urgent and Frequent Urination.**—These symptoms are signs of the involvement of the posterior urethra.

ACUTE POSTERIOR URETHRITIS

Infection of the portion of the urethra proximal to the compressor urethræ muscle commonly takes place about the end of the first week; it may, however, occur during the first few days of the disease, especially when injections have been used too energetically or instruments have been passed, or its onset may be postponed till a much later date; exceptionally this portion of the urethra may remain free from the disease.

The presence of posterior urethritis may be recognizable only by examination of the urine, subjective symptoms being entirely wanting, or these symptoms may be so marked that the patient is in continual distress. Frequent, urgent urination is generally the first subjective symptom of the condition, and is due to the fact that in its acutely inflamed state the mucous membrane of the posterior urethra greatly magnifies the impulse caused by urinary contact, the demand for evacuation being so imperative that it may not be denied. An additional reason for the symptom lies in the customary involvement of the vesical mucosa in the immediate vicinity of the urethral orifice in the disease process.

The milder cases are characterized by frequency. In the more marked cases the frequently recurring desire becomes imperative; the forceful straining effort may void but a few drops, the passage of which gives little relief.

Terminal Hœmaturia.—In addition to the tenesmus, there is frequently hæmaturia—a few drops of pure blood running from the urethra at the end of urination. This is squeezed from the swollen, congested, often eroded mucous membrane of the prostatic urethra. Hemorrhage may be very free. In this case the blood flows back into the bladder and the patient passes it mixed with his urine at the next micturition.

Albuminuria.—During the period when vesical tenesmus is most marked there is always a quantity of albumin in the urine greater than can be accounted for by the pus present. This is probably due to damming back of the urine in the ureters, dependent upon closure of the orifices of these canals by contraction of the detrusor muscles of the bladder, this having been shown to take place when tenesmus is severe.

Perineal Pain.—This when due to tenesmus, *i.e.,* muscular spasm, may be almost unbearable in its intensity. Aside from the suffering by muscular spasm there are usually tickling, burning, or shooting pains in the deep urethra and about the rectum. These are aggravated by micturition or defecation.

Erections are frequent, but are painless unless there is at the same time acute anterior urethritis.

Nocturnal emissions occur repeatedly, and are almost symptomatic of inflammation of the posterior urethra. They are due to hyperæsthesia of the caput gallinaginis, and are often painful, the distress being referred to the deep urethra.

Constitutional Involvement.—Even in mild cases there are, as a rule, transitory fever and slight malaise. Incident to acute posterior involvement, even when the local symptoms are not especially well marked, there are often pronounced fever, headache, pains through the body, particularly in the back,

loss of appetite, and the general misery so identified with "grippe" that the patient himself usually makes this diagnosis of his condition.

Complications.—In the increasing stage, balanitis, balanoposthitis, phimosis, and paraphimosis are the common complications; in the stationary stage, folliculitis and periurethritis, lymphangitis, lymphadenitis, cavernitis, and cowperitis. The complications of posterior urethritis are prostatitis, seminal vesiculitis, epididymitis, and infection of the upper urinary tract (rare). The metastatic lesions of gonorrhœa, arthritis, endocarditis, etc., are generally the sequelæ of posterior urethritis or one of its complications.

Prognosis of Acute Gonorrhœal Urethritis.—This specific inflammation runs its course in from five to eight weeks. If carefully treated, the discharge disappears, the urine remaining absolutely clear of shreds, and the disease is cured. At times, even though treatment has been judicious and has been rigidly carried out, the acute inflammation runs into the chronic form, manifested by a gleety discharge lasting longer than eight weeks; or, in the case of the posterior urethra, by constantly recurring subacute attacks and sexual neuroses of all types. This is especially liable to occur in the strumous and cachectic, in those of gouty or rheumatic tendency, and in patients who are careless in respect to treatment and impatient under restraint. The prognosis as to the time when cure can be expected must always be guarded.

TREATMENT OF ACUTE GONORRHŒA IN THE MALE

Prophylaxis.—The use of a cover sufficiently strong to remain unbroken during coitus, with careful ablution and urination on the completion of the act, is the best means of preventing contagion.

If this be not done one of the following methods should be employed: Immediately after intercourse thorough washing of the penis and surrounding parts with soap and water, and urination with as full a stream as possible, the flow being checked several times during the act by pinching the meatus. As soon thereafter as practicable medication of the urethral mucosa by:

The introduction of a small quantity of 33% calomel in lanolin (dispensed in a collapsible tube for convenience in carrying, or

Injection of a few drops of protargol (0.5%) or argyrol (20%), retaining them for at least five minutes, or

Irrigation of the anterior portion of the anterior urethra with silver nitrate (1:5000) or potassium permanganate (1:4000).

Abortive Treatment.—When patients apply for treatment within forty-eight hours of the beginning of symptoms it is frequently possible to materially shorten the course of the disease. In applying treatment for this purpose it is of the utmost importance to avoid any measures which, in the event of their failure to cure the disease, will leave the urethra in a worse condition than had no treatment been administered. Ballenger's method is as follows:

The penis is cleansed and the meatus anesthetized by laying across it cotton wet with 10 per cent. cocaine. Thereafter 25 minims of a freshly-prepared 5 per cent. solution of argyrol are injected and retained by pressing the lips of the meatus together and sealing them so with flexible collodion. To

facilitate removal of the occluding film a tiny piece of gauze may be included in the *margin* of the collodion dressing. At the end of six hours the collodion is removed (with acetone or by pulling on the gauze), and the patient urinates. Water is taken freely except during the four hours preceding the application of the treatment. The meatal secretion is examined each day before the injection is administered. Gonococci have usually disappeared by the third day. If they are still present on the fifth day the treatment should be abandoned and "systematic treatment" instituted.

The whole course of treatment consists of five injections, on five successive days, after which, if successful, three days are allowed to elapse before administering the beer or other test as a proof of cure.

SYSTEMATIC TREATMENT OF ACUTE GONORRHŒA

To be properly so characterized, each step of the treatment should be carried out with a definite purpose in view, the mode of action of the various agencies employed being thoroughly understood, so that empiricism is reduced to a minimum.

When one considers the pathology of gonorrhœa, the manner in which the gonococci become deeply buried in the urethral mucosa, and the inadequacy of the available drugs to destroy bacteria so buried without injuring to an unjustifiable degree the tissues by which they are surrounded, the futility of depending upon the germicidal power of lotions at once becomes evident. The germicidal power of the tissues is the agency we must look to to eliminate the gonococci, and this power must be maintained at its point of greatest efficiency.

Gonococci are destroyed by the inflammation they excite; inflammation of moderate degree exhibits the greatest germicidal power. The therapeutic indications are met by reducing the more severe grades of inflammation, and by stimulating those which are indolent.

The means at our command for the accomplishment of these purposes consist in regulation of the patient's mode of life, internal medication, and local applications. The first and last are the most important methods.

HYGIENIC MEASURES

These are of special importance in the beginning of the attack, as at this time the inflammation is commonly too severe, and accordingly all factors which tend to irritate the diseased parts are to be avoided.

Exercise.—Violent activity is injurious in two ways; by causing direct traumatism, and by producing an irritating urine. For these reasons rest is to be enjoined, walking being preferred to running, sitting to standing; a reclining posture for a short time at midday and in the evening, the buttocks being elevated, is advisable. Rest in bed is not advised because it is nearly always impracticable, and because it causes a depreciation in bodily vigor.

Occupation, Amusements, etc.—Whatever causes the patient to remain for long periods of time on his feet should be forbidden; if it be impossible for the patient to abandon an undesirable occupation, its evil consequences should be mitigated as far as possible by means of occasional rests.

The patient should be made to understand very clearly that the hyperæmia engendered by even moderate sexual excitement distinctly aggravates the inflammation and postpones his cure; hence he must avoid company, reading, or thoughts which might produce local congestion.

Tobacco is not harmful when used in moderation.

Sleep.—The patient should sleep on a hard mattress, without too much covering; good ventilation should be provided for.

For the avoidance of erections the patient should sleep on his side; a towel tied about the waist with the knot at the back is an aid to the maintenance of this position, or a wooden pill-box may be strapped to the back with adhesive plaster for the same purpose. The bladder should be emptied the last thing before retiring, and once during the night. A prolonged hot bath at bedtime is helpful.

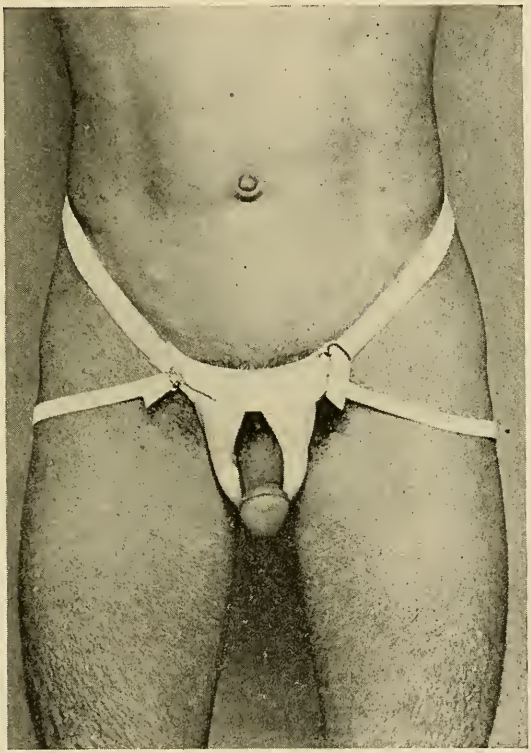


FIG. 101.—Suspensory of suitable design.

Diet.—A simple diet is desirable, that which the patient's experience has shown him is best suited to his needs and is most readily digested. Desserts, highly seasoned food, acid fruits, rhubarb, tomatoes, cabbage, Brussels sprouts, alcohol in any form, and carbonated waters should be forbidden.

Milk (whole milk, skimmed milk, or butter-milk) may be taken freely by those with whom it agrees. The drinking of one or two glasses of water

before each meal, unless this interferes with digestion, is desirable. Not less than two quarts of water should be taken daily. Tea and coffee may be taken in moderation by those who have no idiosyncrasies against them.

Bowels.—At least one daily movement is essential.

Dressing.—If the foreskin entirely covers the penis, the best dressings are composed of four thicknesses of gauze, two inches wide by five inches long, with a diagonal slit cut in the middle. In applying, the central cut is stretched sufficiently to allow passage of the glans, the foreskin being pulled forward over the gauze so as to hold it in place. If the foreskin is absent, the foot of an old stocking, or a bag of similar size made out of any thin material, may be pinned to the shirt in front; at the bottom of this is placed a wad of absorbent gauze, and the penis is allowed to hang in the bag. The gonorrhœal bag made of thin permeable fabric, provided with a buttoned flap which can be turned down readily and fastened as is a suspensory bandage around the loins, is an equally efficient and more convenient dressing. Any dressing which on removal is followed by the immediate escape of one or more drops of discharge, thus showing that there is a damming back, should be discontinued.

The patient must be cautioned in regard to the contagious nature of the discharge. He should wash his hands carefully after each handling of the organ or of the dressing, and should be especially warned of the danger of gonorrhœal conjunctivitis. He should be instructed, in addition to other precautions, to keep his fingers away from his eyes. Since gonococcal infection can be carried by means of towels in the bath, particularly to female infants, the patient must be informed of this fact.

The directions above detailed should be given the first time the patient is seen. A suspensory should always be worn during the acute stages of the disease (Fig. 101).

INTERNAL MEDICATION

Drugs are given for the purpose of altering the character of the urine, and for the relief of pain, spasm, etc.

In the early days of a gonorrhœa the urethral mucosa is so sensitive that urine which is at all acid markedly increases the ardor urinæ which is a characteristic symptom. At this time the urine should be made neutral or slightly akaline by the administration of potassium or sodium bicarbonate, or potassium citrate, at least one and a half drachms a day, in three or more doses, a glass of water being taken after each.

The combination of an alkaline diuretic with sedatives to the circulatory and nervous systems is often advisable. The following combinations are useful:

℞

Tinct. aconiti	♏xlviii
Pot. brom.	℈viii
Pot. acetat.	ʒss
Infus. pareiræ	q. s. ad. fʒviii.

M. S. Tablespoonful in water every two hours.

℞

Tinct. verat.	♏xxxii
Pot. bromid.	
Sod. bicarb.	āā ℈viii
Liq. pot. cit.	q. s. ad. f℥viii.

M. S. Tablespoonful in water every two hours.

A large number of remedies have been employed for the purpose of benefiting the mucous membrane of the urethra, or of killing the gonococci or preventing their growth. Unfortunately all of them are eliminated in such small percentages, and the medicated urine lies in contact with the urethral mucosa for such a short time, that the advantages derived from their use are trifling, especially in disease of the anterior urethra. Sandalwood oil, salol, copaiba, and cubebs are of value in about the order named. The esters of sandalwood, supplied under a number of trade names, are potent, and often cause less irritation than the pure oil. Boric acid is sometimes helpful, especially in inflammation of the posterior urethra and bladder. A combination of several of the drugs often acts better than any one of them alone. The following formulæ are recommended:

℞

Phenylis salicyl. (Salol)	
Oleoresinæ cubebæ	āā gr. v
Copaibæ	♏x
Pepsin	gr. i

℞

Phenyl. salicyl.	gr. iii
Ol. santali	
Copaibæ	āā ♏iii
Ol. Cinnamomi	gtt. i

Four to six of the former capsules or six to ten of the latter should be taken during the twenty-four hours. Copaiba and cubebs should not be given during the early part of the disease.

All of the antiblenorrhagics, the balsams especially, are prone to cause gastric disturbances. This may be avoided in part by administering them after meals. Whenever they cause indigestion, even of the mildest grade, their use should be discontinued. Other disturbances caused by balsamic medication are pain in the lumbar region, hæmaturia, and albuminuria, due to renal irritation; cutaneous eruptions (Fig. 102), urticarial or macular, may occur in patients who are taking copaiba.

Warm baths taken immediately before retiring are useful for the prevention of erections during the night. When these do not suffice, the bromides (30 to 60 grains), hyoscyamine sulphate ($^1/_{200}$ grain), or monobromated camphor (2 grains), may be given during the evening.

For the severe tenesmus and strangury of acute posterior urethritis, opium and belladonna should be given by way of the stomach or rectum, or their alkaloids injected hypodermically.

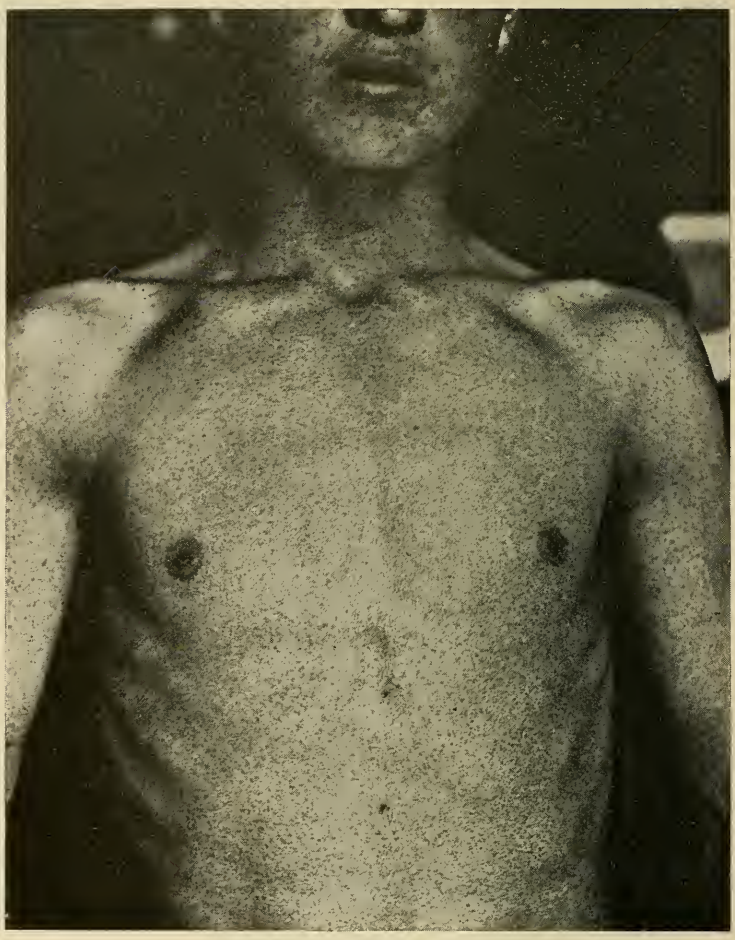


FIG. 102.—Copaiba eruption.

LOCAL TREATMENT

During the acute stage of the disease the local applications consist of injections and irrigations, the former being administered by means of a small syringe (Fig. 103) to the anterior portion of the urethra, the latter by means of hydrostatic pressure to both the anterior and posterior portions of the

FIG. 103.—Urethral syringe.

canal. In some cases instillations into the posterior urethra are employed. Mechanical manipulations and applications through the urethroscope are not indicated.

Local treatment is necessary in practically all cases of urethritis; some can be cured by attention to hygiene and the administration of internal reme-

dies, but the course of the disease so treated is longer and the result is not so well assured.

Treatment by Injections.—The chief advantage of the injection method of treatment lies in the fact that it can be easily carried out by the patient in his home. It is, nevertheless, essential that he be seen by his physician at frequent intervals at the beginning of the attack, at least every other day, that the progress of the case may be observed and the treatment changed as conditions indicate. At the first visit, after the nature of the disease has been definitely determined by means of the microscope, and the necessary hygienic precautions have been outlined, the patient should be carefully instructed in the method of sterilizing and caring for his syringe, and should then be given

Fig. 104.—Anterior urethral injection by patient. The syringe is grasped by the fingers, and the thumb is used to push in the piston.

a practical lesson in its use, syringing his anterior urethra with normal saline solution till the surgeon is satisfied that he knows how the act should be performed. (Fig. 104.)

At the second and subsequent visits the meatal discharge and the freshly voided urine should be inspected, specimens being stained and examined with the microscope from time to time, and according to the course of the disease alterations made in the treatment, or the patient directed to continue as before. At the end of a week or ten days, if the posterior urethra has not become infected so that it requires treatment from the physician in person, the intervals between the patient's visits may be gradually lengthened.

For injections the apparatus needful consists of an aseptible syringe with a short blunt end, that it may not injure the urethral mucosa, the capacity

being from two to four drachms. The syringe may be made of either glass or hard rubber; the glass syringes (with asbestos packing) may be boiled; hard rubber syringes should be sterilized in solutions of phenol or formaldehyde (5 per cent. in either case).

In the most acute cases only bland remedies should be used. Solutions of sodium chloride, 1 to 2 per cent., often act admirably, as do argyrol, in about the same strength, or ichthyol (1 to 1000). Hot general baths or sitz-baths, of ten to fifteen minutes' duration, are of distinct advantage at this stage.

In less inflammatory conditions these same remedies may be prescribed, but in greater strength, or other substances of a more irritant nature may be employed. The organic salts of silver usually give the best results when injections are used. This is probably not so much on account of their bactericidal properties, which are not great, but rather on account of their effect on the urethral tissues.

Argyrol and protargol are the most useful members of the organic-silver group. The former is much the less irritating, and should therefore be used at the beginning of the attack, in from one to five, or even ten, per cent. solution. Unfortunately it stains whatever it touches, so that as soon as conditions permit its employment protargol is the preferable drug. It should be used in solutions of from ⅛ to 1 per cent. Solutions of either drug should be injected and retained in the urethra for five minutes by compressing the meatus three or four times a day, the injections being preceded by urination. Should more than a slight amount of pain be caused by the injections, either their strength or the time of their retention must be reduced.

Potassium permanganate is useful in the injection treatment of gonorrhœa, though it is more often used as an irrigation. Its strength may vary according to conditions from 1 : 12,000 to 1 : 1000, or even 1: 500; 1 : 4000 is the generally useful dilution. The best results are secured with this preparation when it is used as a sort of modified irrigation, the patient using a glassful of the solution in repeatedly syringing his anterior urethra. When it is to be used in this way the following prescription may be given:

℞

Potassii permanganati	gr. xxiv
Aquæ q.s. ad	f℥iii

M. S. A teaspoonful in a glass of boiled water.

NOTE.—It is a convenience to the physician and a safeguard to the patient against the prying eyes of his family to simply number prescriptions, writing the directions **in extenso** on a separate piece of paper. In case it is desired to have the patient resume the use of an earlier prescription, the one meant can then be indicated to him by its number without danger of confusion.

When the discharge lessens in amount, containing a considerable proportion of mucus, the use of "astringent" lotions is indicated, at first in combination with the injections previously employed, substitution for one or more of the injections being made each day, and later alone. The following formula is useful:

℞

Ext. hydrast. fl. (colorless)	f℥vi
Bismuthi subcarb.	℥vi
Boroglycerid. (25 per cent.)	℥vi
Aquæ destil.	℥vi

M. S. Inject after urination.

To this may be added zinc sulphocarbolate in the proportion of five grains to the ounce of water, the bismuth being replaced by this drug towards the end of the attack to enable the surgeon to determine the nature and quantity of the discharge.

Another astringent injection efficacious in the last weeks of gonorrhœa, and serviceable at all stages, is the well-known injection Brou. This is compounded as follows:

℞

Zinc sulphatis	gr. xx
Plumbi acetatis	gr. xx
Tinct. opii	
Tinct. catechu	āā ℥ii
Aquæ	ad f℥vi

M. S. Use as an injection after urination.

Ultzmann's injection is particularly efficacious when in the subsiding stage discharge ceases to diminish under other applications. The formula for this is:

℞

Zinci sulphatis	
Pulv. alum.	āā gr. iv ad gr. xii
Acidi carbolici	gr. iv
Aquæ	f℥vi

M. S. Use by injection, changing the strength in accordance with the indications.

Other astringent injections which may be employed are:

℞

Zinci acetatis	
Acidi tannici	āā gr. xx
Aquæ rosæ	℥iv

℞

Zinci sulphatis	gr. xv
Plumbi subacetatis	gr. xx
Aquæ camphoræ	f℥ii
Aquæ destilatæ	f℥iv

The cessation of treatment should be gradual, the number of injections taken during the course of the day being gradually reduced during a week or ten days. Tests to demonstrate the cure of the condition should be made about a week after the conclusion of the treatment and before the patient is discharged.

In many cases the treatment outlined above cannot be followed on account of the occurrence of posterior urethritis. When this happens there must be sufficient departure from the method to care for the disease in this portion of the canal (see p. 203).

Treatment by Irrigations.—In this method of treatment the urethra is washed with large quantities of fluid, the lotions being made to enter the anterior urethra alone, or both the anterior and posterior portions of the canal, by means of hydrostatic pressure. While it may be carried out by the patient in his home, the apparatus used in the treatment and the large amount of water required are apt to excite attention and comment, so that patients usually come to the office for treatment.

For irrigations the apparatus is almost as simple, though bulkier than that used for injections. It consists of a reservoir, a piece of rubber tubing, four to six feet long, and a blunt nozzle. For the use of patients in their homes a rubber fountain syringe (Fig. 105), fitted with an appropriate nozzle, answers the purpose in a satisfactory manner, but in the office a glass percolator with arrangement for raising and lowering, and a handle for the nozzle provided with some device for the control of the flow of the fluid, such as that of Valentine (Fig. 106), adds greatly to the surgeon's convenience.

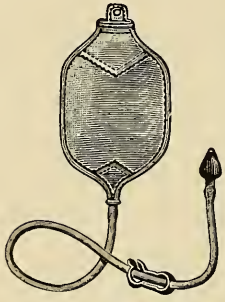


Fig. 105.—Irrigating bag.

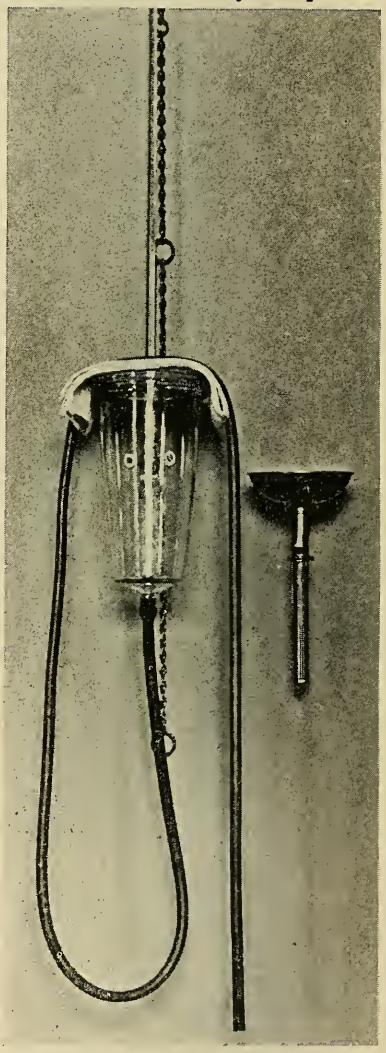


Fig. 106.—Valentine irrigator, as arranged between treatments with tubing across top of percolator.

Dilute solutions of permanganate of potassium are the favorites in this method of treatment. This salt, especially when applied in hot solutions (112° to 120° F.), seems to have the faculty of inducing an œdematous condition in the walls of the urethra which is inimical to the gonococcus. If this condition can be maintained continuously for a period of seven to ten days by the application of lotions of proper strength at appropriate intervals it is possible to cure acute attacks of the disease in this length of time. Unfortunately it does not seem to be always possible to produce this condition, or some strains of the gonococcus are not as susceptible as others to this reaction.

The treatment should be administered twice a day for the first four to six days, and thereafter once a day. Each day before administering the irrigation the urine is inspected to ascertain the extent of the involvement of

the urethra; if the anterior urethra only is affected, the irrigation should be confined to this portion of the canal; when clouding of the second urine shows posterior disease, provided the symptoms are not too acute, weak solutions should be allowed to pass back into the bladder. After the first four to six days the treatments are given once a day. By the end of the third week, if cure has not occurred before that time, intervals of two or three days may be allowed to elapse between treatments. Disease of the prostate is a common complication at this time, so that this gland must be considered in the management of the case.

The irrigations are administered in the following manner: The reservoir is filled with the lotion of choice and the air expelled from the tubing by elevating the nozzle and lowering it slowly; the reservoir is then raised to a height of three to five feet above the patient's chair. The treatments are

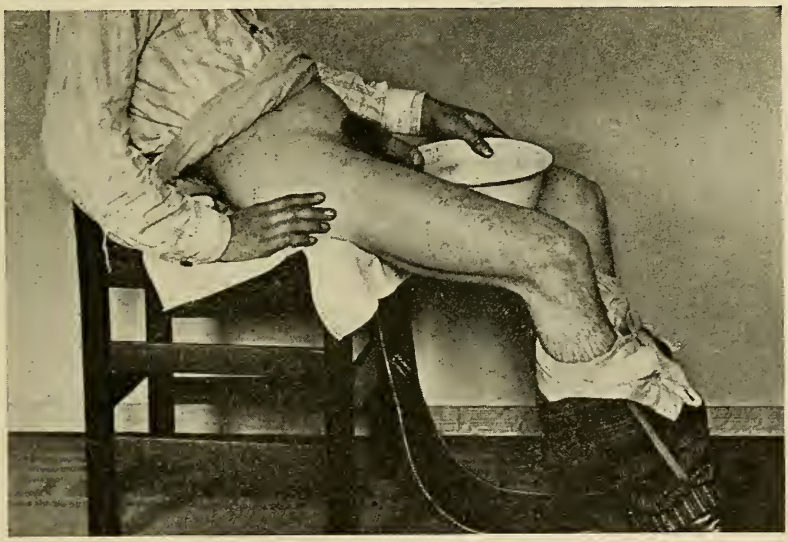


FIG. 107.—Position for irrigation with patient seated.

most conveniently given with the patient seated far forward on a chair, with his shoulders resting against the chair-back (Fig. 107). The trousers and underclothing should be pushed down below the knees so that when the feet are brought together the knees can be separated. The patient holds a basin below his penis for the reception of the escaping fluid. The operator seats himself on a chair or stool at the patient's right, takes the penis in his left hand and the nozzle of the irrigator in his right, and directs a gentle stream against the meatus. While the fingers of the left hand compress the urethra at various points, the tip of the blunt nozzle is introduced into the meatus, and successive sections of the urethra are cleansed by allowing the fluid to flow in and out. If the apparatus is provided with a shield to catch the escaping fluid, as in the Valentine apparatus, the nozzle may be allowed to lie loosely in the meatus, the fluid then escaping beside the nozzle; even

under these circumstances, however, the nozzle must be removed from time to time to allow the urethra to completely empty itself. If the posterior urethra is to be treated as well, after the anterior portion has been thoroughly cleansed the nozzle is made to occlude the meatus, while the patient is directed to relax his muscles as though he were about to pass urine. The fluid then either at once or after the compressor muscle has become tired passes back and fills the bladder.

Irrigations may also be given with the patient lying down or standing (Fig. 108). Some patients are better able to relax their muscles in one of these positions than when seated, and for some the supine position is preferable on account of a tendency to syncope. In this position the escaping fluid may be caught in a shallow basin placed on the patient's thighs, in a douche

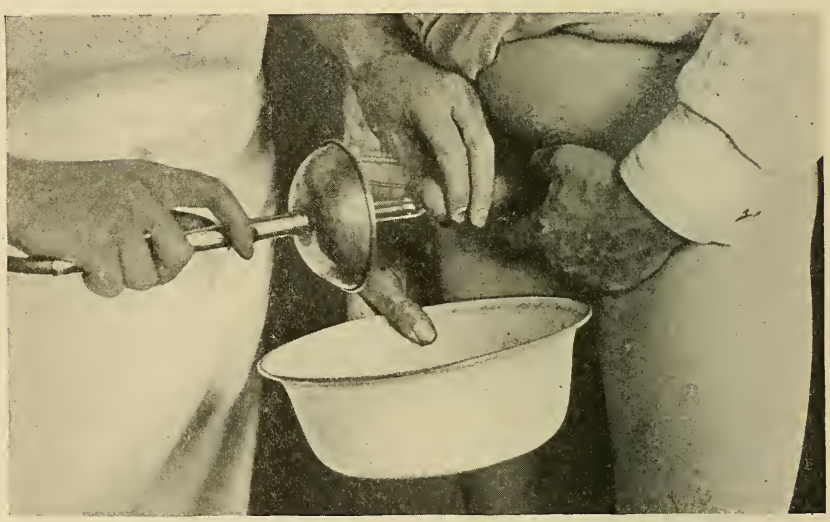


FIG. 108.—Irrigation of the anterior urethra with the patient standing.

pan placed beneath him, or by means of special attachments incorporated in the table.

Solutions.—The lotions used for irrigation include nearly all those used in any form of treatment. The most useful in the majority of cases are those containing permanganate of potash. At the beginning of the treatment this should have a strength not greater than 1 to 4000, and often 1 to 12,000 is sufficient. Later this strength may be increased, even to 1 to 500, though this is rarely of advantage and should never be used in the posterior urethra or bladder; in these a concentration of 1 to 2000 should rarely be exceeded. Other drugs which may be used are sodium chloride, from 1 to 4 per cent.; ammonium sulphichthyolate, from 1 to 10,000 to 1 to 500; zinc permanganate, 1 to 12,000 to 1 to 1000, the effect being much the same as that of the potassium salt, but a trifle more stimulating; and silver nitrate, from 1 to 20,000 to 1 to 1000, this being one of the most valuable drugs, to be used when others seem to have lost their effect, when a lotion with a strong antiseptic

action is desired, or one which will produce a pronounced reaction; unfortunately, even the weakest solutions of silver nitrate sometimes cause burning which is severe and protracted.

ACUTE POSTERIOR URETHRITIS

The treatment of this condition varies with the severity of the process. As a rule, it is better to do nothing locally during the first three or four days after the onset of the infection, and if the inflammation be severe this time may be extended to a week or more. During this time the patient should be careful in his observance of the rules of hygiene, should rest more than he was doing while the inflammation was entirely anterior, should keep his urine bland by the ingestion of large quantities of water, and should take hot sitz-baths twice a day and hot rectal irrigations once a day. In the more severe cases bed-treatment is advisable.

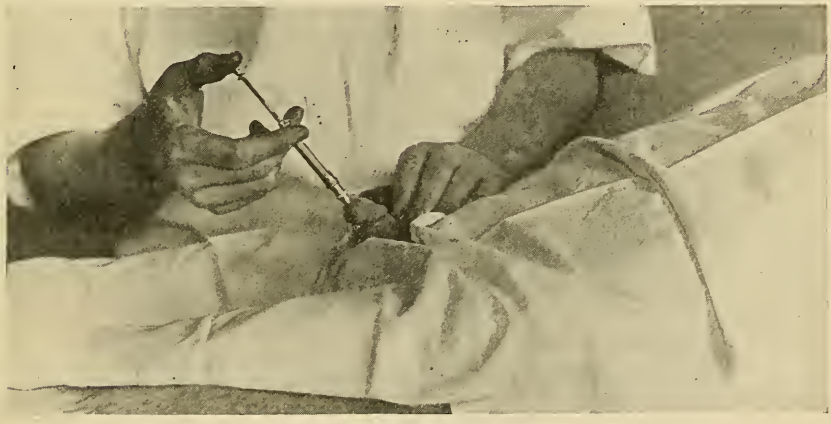


FIG. 109.—Posterior instillation.

The local treatment consists in irrigations; occasionally instillations are indicated.

The irrigations are best given with a short urethral nozzle in the manner already described. In exceptional instances, in which the patient is unable to relax his muscles so as to allow the fluid to enter, or in which the pressure of the fluid causes pain, a small soft-rubber catheter may be used for the introduction of the lotion.

The solutions used when the process is an active one should be the milder of those mentioned (p. 198). Dobell's solution, one-fourth strength, also acts well in many cases. If they give relief, the milder solutions may be used frequently, as often as three times a day.

Instillations are seldom indicated in the acute stage of the disease, but may be used when the condition fails to improve under the treatment outlined, or in presence of persistent, distressing frequency of urination.

The treatment is administered by means of an instillator, a silver or hard-rubber catheter-like tube with a very small lumen, fitted to a small graduated

syringe. The instrument is introduced till the tip has passed the compressor urethræ muscle and lies in the prostatic urethra, its arrival at this point being recognized sometimes by the sense of lessened resistance, usually only by the direction of the handle of the instillator, this making an angle of about 70 degrees with the horizontal when the tip has arrived at the proper point (Fig. 109).

Argyrol (10 per cent.) and silver nitrate (1 per cent.) are the solutions most used. From 2 to 10 minims of either may be applied, the desired quantity being instilled as slowly as possible. The immediate effect is usually to increase the discomfort, relief being experienced after a variable length of time.

CHRONIC GONORRHŒA

A purulent discharge lasting more than eight weeks is indicative of chronic urethritis, or gleet. The essential, and often the only, sign of chronic urethritis is pus. This may be discharged from the meatus, particularly in the morning, or may be found only after careful examination of the urine.

Typical chronic gonorrhœal urethritis is an inflammation of both the anterior and posterior portions of the urethra; occasionally the anterior urethra alone is affected; rarely the posterior portion is the seat of the disease when the anterior canal is normal.

The usual discharge is mucoid and whitish and quite small in amount, sufficient only to stick together the lips of the meatus, or to cause the urine to be slightly cloudy or dotted with small shreds; less often the secretion is thick and yellowish, or even greenish and profuse. It is not uncommon for discharge at the meatus to be entirely absent, its presence being only detected by examination of the urine.

Undue frequency and urgency of urination, signs of posterior involvement, may be scarcely noticeable or harassing and crippling in severity.

Burning and stinging during urination, sometimes after the act, may also be present. The sensation is usually felt in the perineum, or it may be felt at the bladder neck, or about an inch from the end of the penis.

Symptoms of a sexual character, as priapism, sexual irritability, premature ejaculations, etc., are often associated with chronic posterior urethritis, but it is often difficult or impossible to determine whether they are due to the urethritis or to a concomitant prostatitis.

The course of chronic urethritis is usually somewhat varied, being marked at irregular intervals by sudden exacerbations. Thus the chronic, indolent, posterior catarrh may be rendered subacute or even acute by very slight causes, such as exposure to cold, moderate drinking, or coitus. The inflammation then extends forward to the bulbous urethra and there is a more or less free discharge, often associated with slight urgency and undue frequency of micturition. These symptoms subside quickly and are usually attributed to a mild cystitis.

Etiology.—The factors preventing the early cure of gonorrhœa, causing it to become chronic, and tending to perpetuate its existence, relate either to the treatment of the case, to peculiarities of the patient, including the infection of paraurethral structures, or the virulence of the infecting organism.

Either too much or too little treatment may be the cause of failure, the former because the tissues are traumatized and are stimulated to a too great reaction or beyond their power to react, the latter through failure to provoke the antibacterial powers of the tissues; or failure may be due to the patient's neglect of the hygienic regulations prescribed. It is a not uncommon occurrence for a patient, considering himself cured, or nearly so, to bring on a recrudescence by alcoholic indulgence or sexual excitement.

The second group contains the most potent causes for the persistence of urethral discharge. Phimosis of marked degree, reduction in the size of the meatus, especially below 24 F., and stricture interfere with the drainage of the canal and with efficient treatment. Hypospadia and epispadia tend to prolong an infection because of the narrow opening and the abundance of paraurethral crypts and glands. Systemic diseases and derangements act

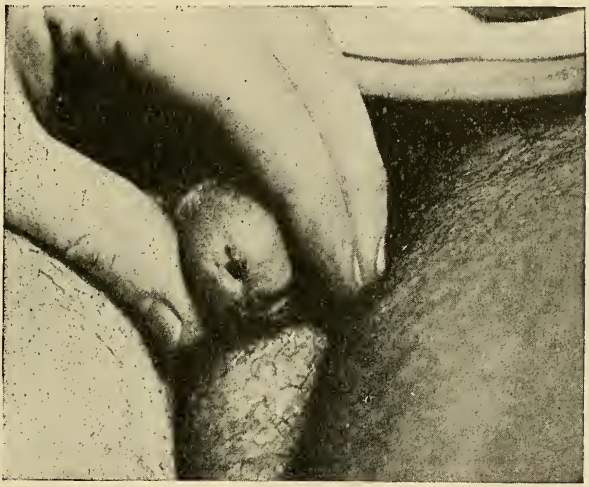


FIG. 110.—Paraurethral sinus at meatus.

either by reducing the vital resistance of the urethral tissues or by the production of an irritant urine; syphilis seems to act in the former manner; diabetes and gout probably have a double mode of action; phosphaturia and oxaluria may render a urethritis incurable.

The infection of paraurethral structures is probably most frequently the cause of the persistence of urethritis. The structures in which such infection is found, in the order of frequency, are the prostate, seminal vesicles, the glands and follicles of the urethra, including Cowper's glands, paraurethral sinuses (Fig. 110), preputial follicles, the kidney pelves, the ureters, and possibly the bladder.

Certain strains of the gonococcus appear to be more virulent than others, and to produce urethritis which is more difficult to cure. Usually, however, unless paraurethral structures are attacked, the disease is merely more inflammatory in type and of slightly longer duration. Unfortunately this type of infection is prone to involve the prostate to a serious degree, even if the other structures escape.

Prognosis.—The ease or difficulty with which chronic urethritis can be cured depends upon the character of the underlying cause of the condition. It is therefore impossible to make any prognosis till a thorough examination has revealed wherewith one is dealing. Even in the absence of periurethral and paraurethral structural changes and infections, chronic inflammation of the urethra is frequently unexpectedly difficult to cure, so that great caution should be used in promising an early recovery.

Diagnosis.—Chronic urethritis is recognized by the finding of pus which has been secreted by the urethral mucosa. Pus present at the meatus necessarily comes from the urethra, unless there be some other obvious source—*e.g.*, a periurethral abscess. Pus found in the urine may come from the urethra or from some other point along the urinary tract, the differentiation being made in part from the symptoms presented and in part by elimination of uninfected organs. Reference to the table on page 207 will be found helpful in making the diagnosis.

The determination of the portion of the urethra which is diseased is made by means of the " glass test " described in Chapter II (see p. 14).

One of the most difficult matters connected with the diagnosis of chronic urethritis consists in the differentiation of gonococcal from nongonococcal inflammations. Even when gonococci are present in the tissues of the urethra they are not always present in the discharge, and when they are present it may be in such small numbers that their detection is extremely difficult. In such cases it is only by repeated careful examinations, some of which are made after the injection of irritant lotions, as silver nitrate, from 1 : 1000 to 1 : 100, that an opinion can be formed.

TREATMENT OF CHRONIC URETHRITIS

Briefly stated, the treatment of chronic urethritis consists of (1) the recognition and removal of the underlying cause of the condition, and (2) the treatment of the urethral inflammation. For the sake of greater convenience, all of these subjects will be considered in the present section.

Order of Procedure.—1. Determination of the source of discharge, whether from the anterior or posterior portion of the urethra, by means of the tests described in Chapter II (p. 14), and of its cellular and bacterial content.

2. Examination to determine the local lesions responsible for the perpetuation of the condition, if any such exist. The nature of the examination varies according to the portion of the urethra affected.

A. *Anterior Urethritis.*—Examination of the region of the meatus and of the glans and prepuce for the presence of paraurethral sinuses or infected follicles. The follicles are usually found in the coronary sulcus, or in the inner layer of the prepuce. Paraurethral sinuses or passages are constantly present in cases of hypospadia and occasionally in normally developed individuals. Their favorite point of opening is near the dorsal commissure of the meatus; in hypospadiacs several of them may exist along the groove of the incomplete portion of the urethra, or they may exist at the sides of the orifice. Their depth varies from a fraction of an inch to several inches.

Table of Differential Diagnosis.

	Acute Anterior Urethritis.	Acute Posterior Urethritis.	Acute Posterior Urethro-Cystitis.	Acute Non-Blennorrhagic Cystitis.	Phosphaturia.	Bacteriuria.
Secretion at the orifice of the urethra.	Abundant.	Less abundant and often contrasting with intensity of turbidity of the urine.	Slight and often contrasting with intensity of turbidity of the urine.	None.	None.	None.
Test of the two beakers.	First portion cloudy. Second portion always clear.	First portion very cloudy. Second portion cloudy, or clear and cloudy alternately; opacity always less than first portion.	First portion cloudy. Second portion always cloudy, difference in opacity of both parts not marked.	First portion cloudy. Second portion always more cloudy than first.	Both portions equally cloudy.	Both portions equally cloudy.
Test of the three beakers.	First portion cloudy. Second and third portions always clear.	First portion very cloudy. Second and third portions cloudy, or clear and cloudy alternately; cloudiness always less than that of first part.	First portion cloudy. Second portion always cloudy. Third portion very cloudy, usually more than first part.	First portion cloudy. Second portion like first. Third portion more cloudy than first and second.	All three portions equally cloudy.	All three portions equally cloudy.
Test of two beakers after irrigation of pars anterior.	Two portions clear.	First portion cloudy. Second portion cloudy, or alternately clear and cloudy; cloudiness always less than first.	First portion cloudy. Second portion more cloudy than first portion.	First portion cloudy. Second portion more cloudy than first portion.	Both portions cloudy.	Both portions cloudy.
Reaction of urine.	Acid.	Acid.	Acid.	Acid or alkaline.	Feebly acid or alkaline.	Strongly acid.
Microscope.	Secretion and sediment of first portion: pus-cells containing gonococci.	Secretion and sediment of both portions: pus-cells containing gonococci.	Secretion: pus-cells containing gonococci, also abundant bladder epithelium in sediment of both portions.	Sediment of both portions: pus-cells, bladder epithelium, no gonococci, numerous bacteria.	Amorphous granules, groups of crystals of calcium phosphate and calcium carbonate.	Numerous bacteria, few cellular elements.
Addition of acetic acid to the urine.	Cloudiness unchanged or increased.[1]	Cloudiness unchanged or slightly increased.[1]	Cloudiness unchanged or slightly increased.[1]	Cloudiness unchanged or slightly increased.[1]	Cloudiness clears.	Cloudiness unchanged.
Other characteristic symptoms.	.....	Vesical tenesmus continuous or imperative; hæmaturia with last drops of urine.	Vesical tenesmus; hæmaturia (from the pars prostatica).	Coagula of pus in alkaline urine.	Very changeable, usually appears only once or twice a day.	

[1] It must not be forgotten that any one of the processes may be complicated with phosphaturia, in which case the addition of acetic acid produces partial clearing up of the urine.

Exploration of the urethra for stricture (see Chapter XIV).

Palpation of the urethra, distended by a sound, for the detection of infected follicles, these when filled with secretion giving the sensation of small shot or beads.

Performance of anterior urethroscopy. This should be a part of the routine procedure in the examination of cases of chronic anterior urethritis, as it is a nontraumatizing operation, and may yield valuable information.

B. *Posterior Urethritis.*—Examination of the prostate and seminal vesicles, expressing and examining their secretions.

Exploration for stricture.

Posterior urethroscopy is only to be done after an adequate trial of the ordinary lines of treatment has proved unavailing, as it can usually be dispensed with altogether and can rarely be conducted without inflicting some traumatism.

C. *Anteroposterior Urethritis.*—All that has been said under the two preceding heads applies to this condition. The most common underlying conditions are prostatitis, seminal vesiculitis, and stricture.

Of the conditions mentioned as complicating chronic urethritis, stricture, prostatitis, and seminal vesiculitis are considered in separate chapters.

Preputial folliculitis is rarely a cause of recurrent attacks of urethritis. When the condition can be removed by circumcision this operation should be performed. When this is impracticable, the choice lies between laying the tracts open with the knife, cauterizing them with the galvanocautery, destroying their epithelium with the electric needle (using the negative pole and about five milliampères of current for half a minute to a minute), or by the injection of cauterant solutions (*e.g.*, silver nitrate, 5 to 10 per cent.).

Paraurethral sinusitis is treated in much the same way. The object is to destroy the tract, either by making it a part of the urethra or causing its obliteration, or, this failing, to overcome its infection. In treating these strucures with cauterant solutions, the possibility—indeed, the probability—of their opening into the urethra must be kept in mind, lest damage be done to the urethral mucosa. When tracts of this nature cannot be treated without resort to the injection of fluids, these must be of a kind tolerated by the urethra.

Folliculitis Urethralis.—This condition may sometimes be overcome by massaging the urethra over a sound, or by passing a full-sized bougie à boule, sometimes only by direct applications through the urethroscope. The passage of instruments and massage should be performed not oftener than once in three days; the object of the treatment is to express the morbific contents and stimulate repair by increasing the blood supply. The urethroscopic treatment consists of incisions to assist drainage, cauterization with the galvanocautery, and destruction with the electrolytic needle. In those cases in which a hollow needle can be inserted into a follicle the treatment may be carried out by injecting a drop of a strong solution of silver nitrate.

Urethral adenitis is treated on the same general principles as folliculitis.

Treatment of the Urethral Infection.—Associated with the superficial, catarrhal inflammation in practically every case there is in addition an infiltration of the deeper tissues. This must therefore be taken into account

in applying treatment for chronic urethritis. These infiltrations are amenable in but slight degree to applications to the surface of the urethra, being most effectively reached by means of a moderate degree of pressure applied by means of sounds and dilators introduced into the urethra.

The use of dilatation is founded on the fact that pressure on the walls of the urethra exerts a profound influence on the condition of the subepithelial tissues. It is not necessary that the pressure be great, and violent pressure is never permissible. All that is necessary for the production of a proper reaction is that the instrument fit the urethra snugly. If the ordinary steel sound will do this, it is the instrument that should be used. On account of the irregular calibre of the urethra, the meatus being usually the smallest part of the whole canal, unless the infiltrations occur at points of physiological narrowing, it is not possible for a cylindrical instrument of fixed size to completely fill the canal at the desired points. For this reason dilators whose size may be changed at will have been devised, the best being those of

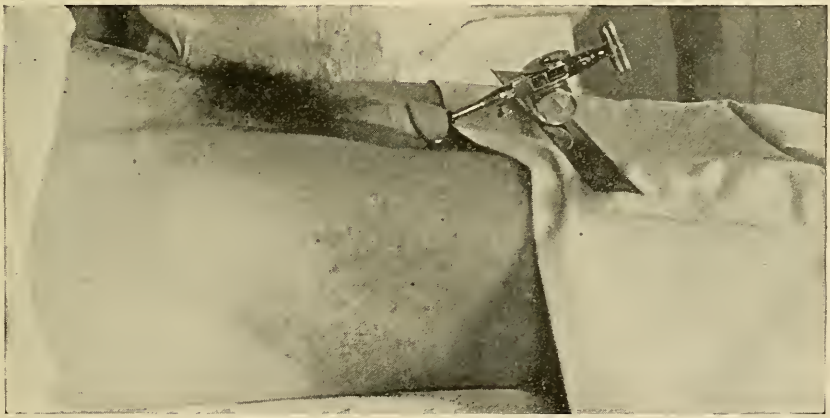


FIG. 111.—Kollmann posterior dilator in use.

Kollman. A straight dilator for the anterior urethra and a curved instrument for the prostatic and bulbous portions are the most useful models.

Dilatations are practised not oftener than twice a week, an interval between treatments being required for reaction to subside. Dilatation is not a stretching; it is rather a method of mechanical therapeusis whereby old inflammatory infiltrations are made to disappear through a reaction in the tissues.

The technique of dilatations by means of cylindrical instruments consists in the introduction of a thoroughly lubricated sound or flexible bougie and allowing it to remain in place for about five minutes. Usually two instruments differing from one another by one or two sizes are passed (see p. 263). In the case of adjustable dilators, the instrument is introduced closed to the desired point and held steadily in this position with the left hand while the right turns the milled wheel on the handle till the dial registers the desired size (Fig. 111). The point of maximum dilatation should be approached

slowly, half a size at a time, thereby accomplishing what is desired with the least possible discomfort to the patient.

Copious irrigations are the most frequently indicated form of treatment in chronic urethritis, not excepting dilatations. They may constitute the sole treatment of the case, or may be merely an auxiliary to other forms of therapeusis, as dilatations or instillations. Practically any drug may be used for the washings, but the most useful and most used are potassium permanganate and silver nitrate. The frequency of their application varies, according to conditions and the progress of the case, from once a day to once a week, the more acute cases requiring treatment at shorter intervals than the more chronic. The strength of the solutions must also be varied according to circumstances and the effect desired. As a rule, the weaker solutions do the

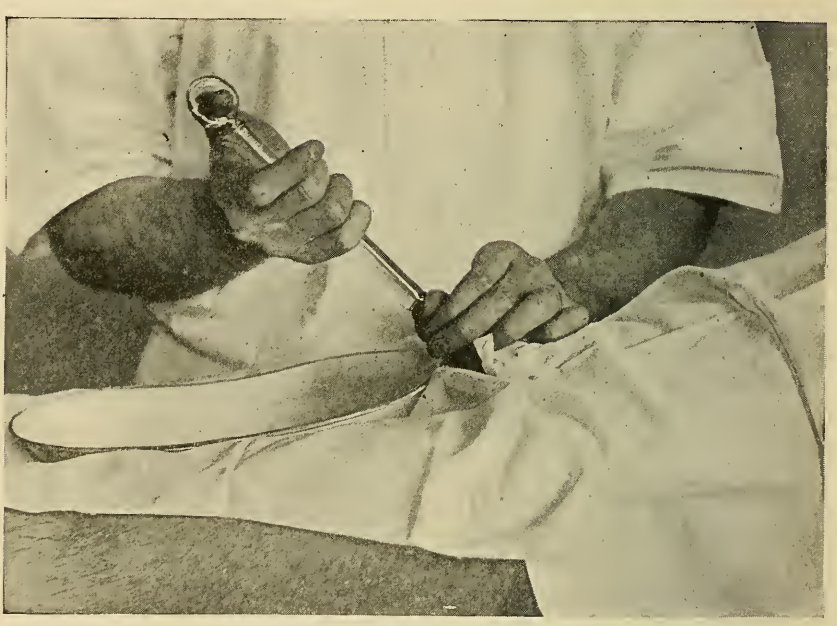


FIG. 112.—Anterior urethral injection.

most good, *e.g.*, 1 : 4000 permanganate or 1 : 10,000 silver nitrate, but when a pronounced reaction is called for much stronger solutions may be used, the silver salt being the one of choice, in solutions up to 1 : 1000 or even 1 : 500. The stronger solutions may be used either after a gradual approach with solutions of increasing strength, or the change may be made suddenly, use of the weaker solutions then being resumed till the reaction excited shall have subsided. Whatever the method of procedure, the object of all treatment, the production of a suitable state of reaction in the tissues, must be constantly kept in mind.

Injections, used by the patient at home or given by the physician in his office (Fig. 112), are very valuable in the treatment of anterior urethritis. For home use the injections mentioned as appropriate for the subsiding stage

of acute urethritis may be employed. In the office similar preparations may be used, or more powerful remedies may be applied. Here again silver nitrate is supreme and may be used in strengths up to 1 per cent. These injections, given once in two or three or four weeks, are sometimes almost magical in the results obtained; they are particularly applicable in cases of mixed infection.

Instillations are to the posterior urethra what injections are to the anterior. Strong solutions are usually used, deposited in three- to ten-drop doses, by means of an instillator, just back of the compressor muscle, the desired result being the production of a powerful reaction. Silver nitrate, 0.5 to 3 per cent.; protargol, 1 to 10 per cent., and copper sulphate, 1 to 5 per cent., are preparations used in this manner. Instillations should not be made oftener than twice a week.

Ointments may be used in either the anterior or posterior portions of the canal for the purpose of producing medication through long periods of time. Traces may still be found after a lapse of three or four days. They may be used either to soothe and protect the mucosa or to stimulate it. Lanolin is the best base for urethral ointments, the other ingredients being selected according to the purpose for which the ointment is employed. The following ointment, suggested by Janet, is of the bland, protective type:

℞

Sodii boratis	gr. x (2 per cent.)
Zinci oxidi	gr. xl (8 per cent.)
Lanolin	q.s. ad. ℥i

The more irritant drugs may be used in rather greater concentration in ointments than in water solutions; thus from 0.5 to 2 per cent. of silver nitrate may be used, or from 2 to 5 per cent. of protargol. For cases in which there is marked cornification or leucoplasia of the mucosa, salicylic ointment, 0.5 to 1 per cent., may be used. Other useful drugs which may be used in this manner are copper sulphate (0.5 to 2 per cent.), zinc sulphate (1 to 3 per cent.), and iodoform (10 per cent.). Iodine may be used in the following combination:

℞

Iodi	gr. ii to iv
Potassii iodidi	gr. xx
Lanolin	℥i

Ointments should be dispensed in collapsible tubes. A conical nozzle which can be screwed directly to the tube then forms a convenient and efficient means of transferring it to the anterior urethra, the salve being then distributed by stripping it along with the fingers. A rather large wad of cotton should be bandaged over the meatus to prevent soiling the clothing. For deposition in the posterior urethra an instrument somewhat similar to the tube of an instillator, but with multiple fenestræ, should be used, the handle being a reservoir for the ointment, fitted with a threaded plunger for its expulsion (see Figs. 9 and 10).

Heat and Cold.—These physical agencies can sometimes be used to great advantage. Heat, if applied in sufficient degree and for a sufficient length of time, has the power of killing bacteria in the tissues, and also of producing an inflammatory reaction. To have any bactericidal power, a temperature in excess of 115° F. must be maintained for upwards of half an hour. This is intolerable to many patients, even when a local anæsthetic has first been applied. Cold (that is, a temperature from 40° to 70° F.) acts only by its

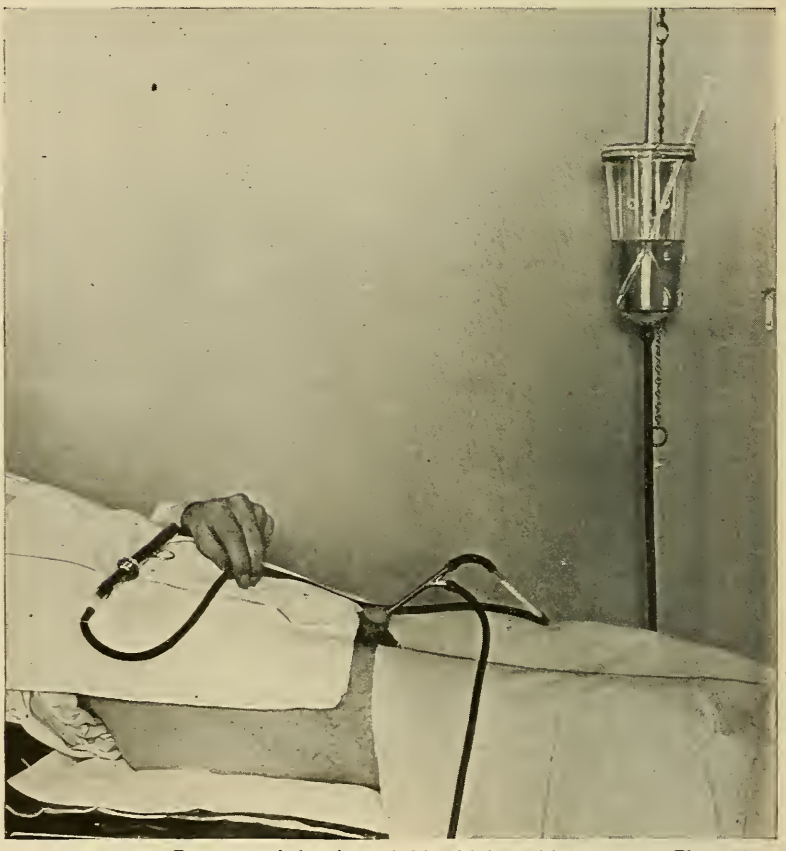


FIG. 113.—Treatment of chronic urethritis with heated instruments. The patient is holding the supply tube, and can control the rate of flow and thereby the temperature of the water in the sound. An infusion thermometer indicates the temperature of the water entering the sound.

stimulant effect on the tissues; it is not complained of by the patient. The duration of the treatments should be from ten to twenty minutes.

Which agency is the more valuable in a given case usually has to be determined by trial. In either case the treatment may have to be continued for a considerable period; six months or a year is sometimes required. The frequency of the treatments varies from twice a week to once in two weeks; an interval of a week is generally most appropriate.

Either heat or cold can be applied with a very simple apparatus, consist-

ing of a reservoir filled with water at the desired temperature, a piece of rubber tubing leading to a double-current sound, or psychrophore, and a second piece of tubing leading to a bucket on the floor to receive the escaping water (Fig. 113). The psychrophore is the only part of the apparatus that need be sterilized. An infusion thermometer placed in the tube just above the psychrophore is a convenience when heat is used. The flow of the solution is regulated by pinching the supply tube with a clamp or by means of a stop-cock. If the patient is allowed to hold the supply tube he can stop the flow should the temperature become too great for endurance, thereby giving him a certain amount of additional confidence.

Bacterin and Serum Therapy.—These agencies have not given sufficiently good results in the treatment of urethral conditions to warrant their routine employment.

THE QUESTION OF CURE

One of the greatest difficulties in the management of a case of gonorrhœa is to determine when the patient has been cured; yet it is a most important matter, not only to the patient himself, but to those with whom he may have sexual relations.

There are two great classes of cases in which this matter comes up for decision. The first class consists of those in whom there seems to have been a complete restoration to the normal, in which every examination fails to show the least sign of disease. These cases may be pronounced cured after the second negative test.

The second class consists of those who still have shreds in their urine, possibly a small mucoid drop at the meatus on waking in the morning, and whose prostatic secretion still contains an excess of leucocytes. Under such circumstances the giving of a proper verdict may be a matter of extreme difficulty, for we know, on the one hand, that gonococci may lurk in the depths of the tissues for several years—just how many we do not know—and, on the other hand, that it is possible for a chronic urethritis, prostatitis, etc., to persist for months and years after all gonococci have been destroyed. The finding of pus in the urine or in the prostatic secretion is therefore not convincing evidence that gonococci are present, yet it indicates the possibility, even the probability, of the presence of these organisms, and it is only after prolonged, yet futile, search on at least six different occasions, with the confirmative evidence of a negative gonococcus complement-fixation test, that a certificate of health may be given. In coming to a decision in such a case it is proper to take into consideration the probable length of time since the last infection ("probable," because patients are not always accurate in their statements concerning such matters), for, while we do not know the extreme limits of viability of the gonococcus in a single host, it is certainly exceptional for an infection to last more than two or three years.

The examination to which the patient should be submitted to determine his state of health should consist, first, of a search for pus from the urethra or adjacent organs, especially the prostate and seminal vesicles, in order to determine the health of these organs, and, second, if pus be found, of a careful

scrutiny of these exudates to ascertain their bacterial content. When urethral pus is present, that first examined should be taken from the meatus or from the urine if it only appears in this fluid; on subsequent occasions it should also be taken from the shoulder of a bougie à boule. Several of the examinations should be made about twelve hours after treatment with nitrate of silver, so-called "provocative" injections and instillations being made of solutions of from 1 to 1000 to 1 to 100 into the anterior and posterior portions of the canal, and others after the patient has partaken freely of alcohol.

The examinations of the secretions of the prostate and seminal vesicles must be made from specimens secured by massaging and stripping these organs as described in the chapters on "Prostatitis" and "Vesiculitis." Gram's method of staining should be used in the examination of all suspicious forms.

The complement-fixation test, based on the same principles as other tests of a similar nature, when performed by a man experienced in this kind of work, using an antigen made up from a number of different strains of gonococci, is a valuable addition to our means of determining when a patient has been cured. As the test never becomes positive till four to six weeks after the onset of the infection, it is useless in the early stages of the disease. But when the gonococci have invaded the deeper tissues the test is usually positive, and it then remains positive till after the gonococci have been eliminated, probably for several weeks after that time, so that in the later stages of the disease a negative test, and especially a negative test obtained after the reaction has been positive, is a valuable piece of evidence.

CHAPTER XI

GONORRHŒA IN WOMEN AND CHILDREN

GONORRHŒA IN WOMEN

Frequency of the Disease.—Leaving aside the consideration of harlots, practically all of whom suffer from some of the acute or chronic forms of the disease, gonorrhœa attacks a large number of reputable women. The gloomy Noeggerath states that eighty per cent. of women are affected with latent gonorrhœa, while Sänger found that of nineteen hundred and thirty women coming to his clinic twelve per cent. had this disease. Young married women become infected because long-standing gleet in man has not been regarded as a bar to matrimony. The symptoms of gonorrhœa in women may be so slight as not to be attributed by the patient to any cause more serious than a cold, a strain, the traumatism of the defloweration, or some irregularity in her periodical sickness, and hence treatment is often neglected.

Seat of Infection.—In women, as in men, the urethra is most frequently involved in the gonorrhœal inflammation. Next in order of frequency comes the mucous membrane of the cervix, then that of the uterus, and finally that of the Fallopian tubes.

Vaginitis, at least that directly due to the gonococcus, is extremely rare, except in children, and possibly in young women recently deflowered.

Vulvitis is not uncommon, and is often accompanied by inflammation of the glands of Bartholin.

Contagion.—As in the male, gonorrhœa is acute or chronic. Though it is usually conveyed during sexual intercourse, the possibilities of mediate contagion through bathing-water, garments, towels, etc., are much greater in women than in men.

In girl babies the disease is nearly always acquired by mediate contagion. The discharge is derived sometimes from a gonorrhœal ophthalmia, generally from the genital tract of the mother. Only very exceptionally is the contagion immediate and from criminal practices.

Acute gonorrhœa is usually acquired from the discharge of an acute case, though there can be no doubt that chronic gonorrhœa in the male may excite a florid attack in the female. Gleety discharges, if contagious, sometimes give rise to a subacute attack.

Symptoms.—The symptoms of acute gonorrhœa are at the beginning usually those of acute vulvitis and urethritis; in children and young girls there is also an acute vaginitis.

The patient complains of a sense of heat and burning about the genitalia, of profuse purulent discharge, of ardor urinæ, and of urgency and frequency of micturition.

If the uterine mucous membrane is also involved there are usually marked constitutional symptoms, *i.e.*, fever and depression, and, in addition, severe

pains in the uterine region, swelling of the womb, and bloody purulent discharge from it. Not infrequently perimetritis complicates the uterine inflammation.

An examination shows the mucous membrane of the vulva and sometimes that of the vagina infiltrated, reddened, and eroded. Pus can be milked from the urethra.

The subacute gonorrhœa sometimes acquired from chronic gonorrhœa of the male rarely shows itself by pronounced typical symptoms. There are intermittent attacks of slight ardor urinæ, frequency of micturition, disorders of menstruation, pelvic pains, and disturbances in the uterine function, manifested by dysmenorrhœa, by sterility, by abortion, and by attacks of perimetritis, salpingitis, ovaritis, or local or general peritonitis. The patients gradually lose their health, become unfit for work of any kind, and are prone to develop into typical neurasthenics.

On examination there will usually be found a catarrhal condition of Bartholin's glands and of the periurethral follicles. Purulent secretion escapes from the cervical canal, which is sometimes eroded. The uterus is found enlarged, tender on pressure, and fixed from attacks of perimetritis. The ovaries and tubes are often enlarged, displaced, and fixed.

Diagnosis.—In the ordinary acute case this is not difficult, since the symptoms themselves are almost characteristic, and the detection of the gonococcus will at once settle the nature of the attack.

The subacute form is sometimes extremely difficult to diagnose, since the gonococcus may not be found. According to Sänger, in arriving at such a diagnosis careful search should be made for acute or chronic gonorrhœa in the husband, or a history of gonorrhœa subsequently cured. The presence of gonorrhœal ophthalmia in children is highly suggestive.

Matters of diagnostic import are: a history of uterine catarrh without obvious cause; disease of Bartholin's glands, and especially redness of the skin surrounding their ducts; the presence of condylomata; the discharge of muco-purulent matter from the cervix without erosions or pseudo-erosions of the os; disease of the adnexa or of the pelvic peritoneum. Without doubt many of these affections may be due to other germs than the gonococcus, such complications representing a form of mixed infection.

URETHRITIS

The urethra is nearly always involved in gonorrhœal infection, and the presence of inflammation in this canal is in itself presumptive evidence of the nature of the infection.

Acute Urethritis.—The acute stage of the disease is brief, and is accompanied by symptoms of moderate severity as compared with urethritis in the male. It is less liable to become chronic than is the case in men, or if it lingers it causes symptoms so slight that they are readily overlooked; hence the frequency of the involvement of the urethra in gonorrhœal inflammation is often underestimated.

Symptoms.—These are very much like those observed in men. The incubation period varies from a few hours to five or six days, and exceptionally

is much longer. Slight tickling or burning sensations on urination, moderate purulent discharge, demonstrated by milking the urethra from above downward, and a swollen, œdematous urethral orifice are often the only symptoms which can be detected, though in specially sensitive women there will be at the beginning of the attack rigors, slight fever, and general malaise. In from a few days to two or three weeks even these symptoms disappear, and the disease is regarded as cured.

Finger believes, however, that it becomes chronic in women much more frequently than is the case in men, being subject to exacerbations, and often months after the original attack exciting a urethrocystitis, the symptoms and course of which are much like those of the same condition in man, except that it is less severe and more amenable to treatment.

Chronic urethritis rarely excites sufficiently characteristic symptoms to suggest a probable diagnosis without a thorough examination. This should be conducted at a time when the patient has not urinated for several hours. Pressure on the urethra from behind forward may show that this tube is thickened and somewhat sensitive, and will usually press out a thin, milky, mucopurulent drop. In case there is not sufficient discharge for this, the vulva and vagina are carefully washed and the patient is requested to urinate in two portions. Clap-shreds and pus will be found in the first portion; if pus is discovered in the last portion, this is usually indicative of the presence of chronic cystitis.

An endoscopic examination in cases of acute urethritis in women shows redness, swelling, and general acute congestion of the mucous membrane. In the chronic cases diffuse redness, areas of epithelial thickening, and sometimes comparatively deep erosions are observed, the latter especially about the openings of follicles.

Folliculitis.—As in the male, the urethra contains many follicles, and these are subject to gonorrhœal inflammation, forming small tender tumors which commonly evacuate their contents into the urethra.

There are two follicles, known as Skene's tubules, which are particularly liable to become infected. These are situated in the lower urethral wall and open just within the external urethral orifice. A fine probe can be inserted into the duct of each to a depth of from one-half to three-fourths of an inch. When these follicles are acutely inflamed and their urethral openings firmly blocked, the softening and breaking down may cause urethrovestibular or urethrovaginal fistulæ.

In addition to these two deep follicles, there are a number of smaller ones situated about the meatus. Many or all of these may become inflamed, rendering the urethral opening unsymmetrical. They often rupture into the urethra, but again fill up and continue to discharge intermittently.

The frequency with which these follicles are involved in gonorrhœal inflammation makes their recognition particularly important. A careful examination usually shows at once the true nature of the case, since immediately after the urethra has been washed clean by the act of urination pressure causes exudation of pus. Moreover, on direct examination the inflamed openings of the follicles can generally be found.

Diagnosis.—The diagnosis of acute urethritis is dependent upon the symptoms and on finding the gonococcus.

If after holding the water for several hours no pus can be milked from the urethra, the vulva and vagina should be washed free of discharge. The patient should then micturate, and the urine should be carefully examined for pus.

Prognosis.—The prognosis of urethritis in women is much more favorable than in men. The disease lasts for but a short time; the chronic forms of it occasion no trouble and usually undergo spontaneous cure without producing serious or permanent alterations in the urethral mucous membrane.

Treatment.—The treatment of acute urethritis in women is conducted on the same principles as govern the management of this disease in men. The diet is regulated, and the urine is rendered unirritating by the administration of potassium citrate or sodium bicarbonate and an abundance of water.

Balsams may be given from the first, and as soon as the acute symptoms subside injections are employed. These should be driven in by the ordinary clap syringe, but not more than half a drachm should be injected at one time. The solutions employed are those used in the male urethra, but may be slightly stronger. As soon as the acute stage is past the lesions are located by the urethroscope, and are treated directly by means of iodine two to ten per cent.

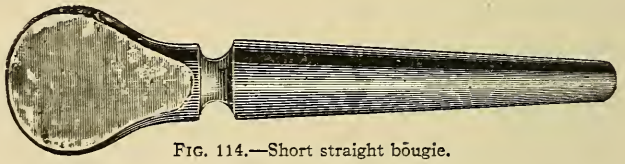


Fig. 114.—Short straight bougie.

solution in glycerin, or silver nitrate one to ten per cent., these drugs of course, being applied only to the inflamed spots by means of cotton tampons.

Chronic urethritis in women is usually dependent upon folliculitis, either the paraurethral glands about the meatus or a group of follicles near the neck of the bladder being involved. Destruction of the follicles by a finely pointed stick of silver nitrate or the electric needle when they are accessible, or when the inflammation is placed near the bladder, the use of the endoscope for the appli-tion of iodine or silver nitrate, is indicated in these cases.

Exceptionally true stricture forms, usually at or near the meatus. The symptoms are frequent micturition, slight dribbling, and gleet, though the latter is rarely noticed. The fact that stricture may result from gonorrhœal inflammation of the female urethra would suggest a search for this condition in cases of functional urinary difficulty in women. The diagnosis is readily made by means of the bulbous bougie. Narrowing at or very near the meatus may require division, the knife cutting backward. Gradual dilatation will prove efficient for all other cases not traumatic. Straight metal bougies are employed running up to 40 F. (Fig. 114).

There is one form of chronic urethritis much resembling in symptoms the posterior urethritis observed in men. The patient complains of frequent urgent urination, tenesmus, and reflexes, such as vaginismus and backache, and a general condition of neurasthenia. On urethroscopic examination the mucous

membrane at the neck of the bladder—*i.e.*, within the grip of the vesical sphincter—is found greatly thickened and congested or even fissured.

The treatment consists in wide dilatation (40 to 50 F.) and the application of strong solutions of silver nitrate.

VULVITIS

Inflammation of the vulva is characterized by œdematous swelling, redness, and erosions affecting the greater and the lesser lips, and by a profuse purulent, irritating, extremely fetid discharge. This discharge coming in contact with the neighboring skin produces a dermatitis, which may pass backward towards the anus or downward along the inner surfaces of the thighs. There are constant itching and burning about the vulva, which become aggravated to severe pain by walking or motion of any kind involving the lower half of the body. Trickling of the urine over the abraded surfaces occasions much burning. Involvement of the inguinal glands is by no means uncommon.

Usually vulvitis has a tendency to spontaneous recovery. Occasionally, especially in children, it becomes chronic, persisting in the vestibular glands, and not only in those about the urethra, but also in those placed at the inner surface of the lesser lips. These chronically inflamed glands cause practically no symptoms, and are detected only by direct examination. Hyperæmic or eroded spots may be found overlying the swollen glands, which can sometimes be felt as small nodules; condylomata are frequently observed.

Treatment.—Cleanliness will usually accomplish cure, which is hastened by the employment of antiseptic and astringent lotions and by protecting inflamed surfaces from contact with the urine. In the acute stages the treatment consists in irrigation with very hot saline solution containing 1 to 6000 bichloride of mercury, practised twice a day, or more frequently if the discharge is free. Each irrigation is followed by the insertion between the greater and the lesser lip on each side of a thin sheet of cotton dipped in dilute lead water. This cotton should be changed every two or three hours. As the symptoms subside the inflamed parts should be painted once daily with a one per cent. solution of silver nitrate, and the irrigation should be followed by the use of an astringent dusting powder and dry cotton.

BARTHOLINITIS

Inflammation of Bartholin's glands is perhaps the most frequent complication of vulvitis, though even this is exceptional. It may be either acute or chronic. Whether it be due to infection of these glands by gonococci or by the ordinary pus microbes, the clinical fact remains that it is so rarely associated with non-gonorrhœal forms of vulvitis that if it occurs it is almost pathognomonic of gonorrhœa.

Acute Bartholinitis.—Acute inflammation of these glands develops suddenly, either during the fulminant stage of acute clap or long afterwards, from lighting up of the chronic inflammation by sexual excess or other cause.

There appears in the posterior third of the greater lip, usually on one side alone, though sometimes on each side, a tender, hard, very clearly outlined tumor about the size of a hazel-nut. This is soon followed by an œdematous

swelling of the greater lip, sometimes extending to the lesser lip, and often as far forward as the prepuce of the clitoris. In place of a distinctly outlined tumor there develops a dense inflammatory infiltration, forming an extremely tender, painful swelling, often as large as a pigeon's egg, the surface of which is red. Shortly fluctuation is detected, suppuration being denoted at the same time by the constitutional symptoms of pus-formation.

The pus may break through the capsule of the gland, the overlying skin remaining intact. In this case it is apt to burrow backward along the perineum, forming extensive sinuses, and even opening into the rectum. Usually the skin also ulcerates and the pus is evacuated on the inner surface of the greater lip. This pus is blood-stained and foul-smelling.

Chronic Bartholinitis.—Chronic inflammation of Bartholin's glands may appear as an inflammation of the gland-ducts alone, the most frequent form, or may involve the gland substance. In the latter case hard nodules are felt on palpation, and on pressure a purulent fluid containing gonococci can be forced from the ducts. When the ducts alone are infected no induration will be felt on palpation, and on inspection nothing in seen except an area of hyperæmic, or possibly eroded, mucous membrane around the duct opening. Pressure may cause a small drop of purulent fluid to exude. Sometimes a large quantity of this fluid can be squeezed out, owing to retention from blocking of the duct. Not infrequently this duct is the only mucous surface in which the gonococci still survive: hence in an examination to confirm the presence or the absence of gonorrhœa the condition of Bartholin's glands and their ducts must always be most carefully investigated.

Treatment.—The treatment of the acute inflammation in the early stages before there is pus-formation consists in putting the patient to bed, keeping the bowels open, and applying evaporating lotions, constantly renewed. Of these, lead water and dilute alcohol are perhaps the best. As soon as fluctuation is detected, or when the constitutional symptoms denote pus-formation, the pus should be evacuated by a free incision made on the inner surface of the greater lip. The cavity should be curetted, washed with 1 to 1000 bichloride solution, and packed with iodoform gauze. This packing must be repeated frequently, and the cavity must be made to heal from the bottom.

Chronic inflammation is extremely difficult to cure. When the gland is involved and appears as a hard, slightly tender, circumscribed tumor subject to occasional attacks of subacute inflammation, the whole gland should be dissected out. If the ducts alone are involved, the catarrhal process may be cured by astringent and antiseptic injections carried in by means of a hypodermic needle blunted at the end. Usually, however, it will be necessary to split the duct thoroughly, scrape it, and pack with iodoform gauze until healing takes place.

METRITIS

Acute metritis develops in the course of acute urethritis, vulvitis, or vaginitis. It is characterized by rigors and fever, pain in the hypogastric and sacral regions, generally aggravated by motion, and a discharge from the cervix, at first muco-purulent, then frankly purulent. On examination the womb is

found to be tender and enlarged, and the cervix is swollen, œdematous, and often eroded.

The inflammation may be limited to the cervical mucous membrane. More commonly it involves the entire endometrium, and it may extend to the perimetrium, tubes, ovaries, and peritoneum.

Diagnosis.—The diagnosis is founded on the coexistence of urethritis, bartholinitis, etc., and on the discovery of the gonococcus.

Prognosis.—The prognosis as to complete cure must be guarded, since the disease has a tendency after subsidence of acute symptoms to linger indefinitely.

CHRONIC METRITIS, according to Finger, is acquired from the discharges of a chronic gonorrhœa of the urethra or external genitalia of the woman, the uterus having escaped during the acute stage of the disease, or is implanted by a male suffering from gleet. This form of metritis is the one commonly observed in young married women infected by their husbands.

Symptoms.—The inflammation is ushered in by a mucopurulent discharge, which excites little attention, since it is attributed to cold, defloration, excess, or other apparently sufficient cause. The discharge becomes profuse at times, and is especially free after the menstrual period. Gradually menstruation becomes painful and irregular and the flow is scanty; at the same time there is a deterioration in general health, with a sense of weight and dragging about the uterus, and the patient becomes neurotic and unfit for work.

The course of the chronic inflammation is varied by intercurrent subacute attacks, somewhat simulating acute metritis.

On examination a swollen, tender uterus is found, from which is discharged mucopus. The gonococci can rarely be discovered in this discharge.

Diagnosis.—The diagnosis of chronic gonorrhœal metritis is extremely difficult. A preceding history of acute gonorrhœa, a venereal record on the part of the husband, or infection of others by the discharges, would strongly suggest the causative agency of the gonococcus in producing this inflammation.

Prognosis.—This form of inflammation has little tendency towards spontaneous cure; rather it extends slowly, particularly in the direction of the tubes and ovaries, producing sterility and chronic invalidism, and in many cases ultimately destroying life.

GONORRHŒAL SALPINGITIS AND OÖPHORITIS

These are caused by an extension of the gonorrhœal inflammation to the tubes and ovaries, and are not characterized by any pathognomonic symptoms. Menstruation is usually irregular, profuse, and very painful, intercurrent attacks of pelvic peritonitis occur, and there is often a rapid loss of health. All these symptoms are also observed in endometritis.

The tubes may be filled with pus, and this pus may escape into the uterus or may make a way for itself into the bowel, the case thus recovering spontaneously, or it may ulcerate through the tube or escape by its fimbriated extremity and occasion a fulminant form of peritonitis.

With involvement and obliteration of the tubes the ovaries are nearly always diseased, first a parovaritis developing, followed by atrophy and cyst-formation of the ovary.

Diagnosis.—The diagnosis of gonorrhœal salpingitis and ovaritis must be founded on bimanual examination, preferably with the patient well relaxed by ether.

PERIMETRITIS

The acute form of perimetritis is most prone to develop during pregnancy or after childbirth. The symptoms are those of acute pelvic peritonitis and septic absorption,—*i.e.*, pain, tenderness, vomiting, and fever,—and may terminate fatally in a few days. More commonly resolution takes place, even though there is apparently a large exudate. This Sänger considers typical of gonorrhœal infection.

The recurring form of perimetritis is due to pus-tubes; the symptoms are those of acute local peritonitis, and are most severe and lasting during the first attack. In the intervals the woman may enjoy perfect health.

The chronic form is characterized by persistent pain and tenderness. Every strain or jar is unbearable, coitus is not possible, and there is usually a marked condition of neurasthenia.

Treatment.—Gonorrhœal cervical endometritis should be treated first by thoroughly cleansing the vagina with antiseptic douches, 1 to 2000 bichloride (hot). The cervix is then exposed and its endometrium cleared of the viscid mucus which coats its surface by means of cotton tampons. Finally, the whole diseased surface is touched with one of the following solutions, named in the order of their efficiency: 1, silver nitrate ten per cent.; 2, tincture of iodine; 3, copper sulphate ten per cent.

Small cysts found in this form of inflammation should be punctured, and when there is marked congestion local depletion is indicated, the cervix being scarified by means of a long-handled knife.

When the inflammation resists these milder forms of treatment, a thorough curetting, followed by the application of zinc chloride, twenty per cent. solution, and by packing with iodoform gauze, will be indicated.

Endometritis involving the body of the womb should receive no direct treatment during the acute stage. Rest in bed, hot vaginal douches, free action on the bowels by salines, and, when pain is very intense, the administration of an anodyne, represent the safest and most efficient treatment in this stage. Even when the disease has become chronic it is safer not to perform intra-uterine applications in the office. The general health should receive attention; the activity of the patient should be limited, especially just before, during, and immediately after the menses. Hot douches are of advantage in this condition also, as are local applications to diseased conditions in the cervix, and tampons moistened with glycerite of boroglycerin, ichthyol, etc. If these measures fail to produce a cure, in the absence of disease of the adnexa the cervix should be dilated and the uterus thoroughly curetted and treated with tincture of iodine, general anæsthesia being employed. When the disease has extended to the parametrium, tubes, ovaries, and pelvic peritoneum, causing the local and general symptoms of acute pelvic peritonitis, free movements of the bowels, prolonged hot baths, and hot vaginal douches are indicated until the acute stage has passed and very definite localizing symptoms point to the use of the knife.

VAGINITIS

Inflammation of the vagina, at one time regarded as the most characteristic manifestation of gonorrhœa in the female, is now recognized as occurring much less frequently than urethritis or endometritis. The many layers of squamous epithelium are usually sufficient to prevent penetration of the gonococci. When, however, the vaginal mucous membrane is succulent and the spaces between the epithelial cells are widened, as in infants and children, or in young virgins, the gonococci may penetrate deeply and produce a true vaginitis. The vaginal inflammation sometimes noted in older women is often due to the irritating effect of decomposing discharges which flow from the endometrium.

Symptoms.—A sense of weight and burning in the vagina, aggravated by motion, a free purulent discharge, and slight fever and malaise are the only symptoms of which the patient complains. An examination shows the vaginal mucous membrane reddened, œdematous, and freely suppurating, and its walls somewhat stiffened by recent inflammatory exudation. The epithelium is eroded in places, and there are observed extensive granular patches, especially in pregnant women. Often there is so much tenderness that examination either by the finger or by the speculum is impossible.

Diagnosis.—This is founded on ocular and digital examination showing an acute inflammation of the vagina, usually associated with urethritis and vulvitis, and often with endometritis. The gonococcus may be found.

Prognosis.—In itself gonorrhœal vaginitis is not a serious affection. It is usually cured in two or three weeks. Exceptionally it becomes chronic, and in prostitutes causes a stiffened, dry, rough condition of the mucous membrane, termed xerosis vaginæ.

Treatment.—This should be cleansing and antiseptic. Twice a day the vagina is flushed out with two quarts of normal saline solution (nine-tenths per cent.) containing 1 to 4000 corrosive sublimate. This douche is best given from a fountain syringe raised two to four feet. During its administration the patient should lie on her back, with the hips slightly elevated, or, better still, should assume the knee-elbow position. When there is a bath-tub these flushings are easily managed.

When the acute symptoms have subsided, a speculum is introduced, and the inflamed and granular patches, or the entire vagina if all its surface is involved, are painted with ten per cent. silver nitrate solution. This is repeated in three days if necessary. Tincture of iodine may be used in place of the silver nitrate. In cases seen early, or where the inflammation is not so acute that insertion of a speculum is very painful, the silver nitrate painting is indicated from the first.

In chronic cases, irrigation, followed by paintings of the vagina with strong solutions of silver or copper ten per cent., or iodine tincture, and then by tamponing with iodoform gauze, is repeated daily for from five to seven days; then dilute antiseptic washes are employed once daily for two weeks till epithelial regeneration is completed. Suppositories of tannin and boric acid (ten grains of each) inserted twice daily will greatly lessen the discharge, and will sometimes cure a chronic inflammation when other means have failed.

THE QUESTION OF CURE

In women the detection of the gonococcus when these organisms are present in small numbers is much more difficult than in men, on account of anatomical differences. The regions which should be specially examined are the urethra, including Skene's tubules, Bartholin's glands, and the cervix uteri. Repeated examinations of the discharge or secretions from these points should be made, the most favorable time being immediately before or at the conclusion of the menses. Alcoholic indulgence also increases the likelihood of finding gonococci; application of the glycerite of boroglycerin to the cervix by means of a tampon inserted the day before the examination is to be made is often of advantage on account of the mild reaction excited.

In coming to a decision as to the health of such a patient one must always take into consideration the length of time which has elapsed since infection, and the point to which the infection apparently travelled, a careful bimanual pelvic examination being made to ascertain the present condition of the tubes and ovaries. The probability of cure, that is of freedom from gonococci, is directly proportionate to the time which has elapsed since infection, and inversely proportionate to the extent to which the disease became disseminated.

In deciding the question of the marriageability of a woman who has had gonorrhœa one must consider the possible structural changes which may have taken place in the tubes, and which may render the patient sterile or liable to extra-uterine pregnancy, as well as the actual presence of gonococci in her secretions.

In women even more than in men is the gonococcus fixation test a valuable means of determining when a patient may be considered well. It is almost always positive when the uterus or adnexa is infected.

GONORRHŒA IN CHILDREN

Male Children.—The course of gonorrhœa as observed in male children is not markedly different in symptomatology, duration, or treatment from the disease as it occurs in adults. It is a rare disease, at least in boys under twelve years of age, in this respect affording a marked contrast to gonorrhœal vulvovaginitis observed in the opposite sex. The cause is usually an attempt at intercourse, often suggested by a much older female. Very exceptionally the contagion may be mediate by means of fabrics or by foreign bodies previously infected being introduced within the urethra. When the disease develops in boys over twelve years of age it is usually acquired in the ordinary manner.

Symptoms.—These are the same as have been already described. They develop more quickly after exposure to contagion, and run a somewhat more acute course than is customary in the adult, the whole penis usually being swollen, the discharge being profuse, and the child complaining bitterly of the pain incident to micturition and erection.

Complications.—Of these the most frequent is balanoposthitis, incident, no doubt, to the phimosis usually present in children and to the vulnerability of the mucous coverings of the glans and foreskin. Indeed, other complications are rare, though a number of well-authenticated instances of epididymitis

are reported. Hyperacute posterior urethritis and urethrocystitis are by no means exceptional. There is usually pronounced fever.

Diagnosis.—This is founded on the presence of the gonococcus. The search for the gonococcus should always be made, since simple irritative urethritis is by no means uncommon in children, and is in the beginning of its course not to be distinguished clinically from true gonorrhœa. This simple urethritis is often excited by the introduction of foreign bodies, by a simple balanoposthitis, and by the irritation incident to the passage of highly condensed urine.

It is usually mild and of short duration, contrasting with the inflammation resulting from the presence of the gonococcus.

The prognosis is favorable, the discharge usually ceasing in from three to six weeks. In weak, strumous, cachectic children it is liable to last much longer and may run into gleet. Stricture has been observed as a sequel.

Treatment.—This consists in rest in bed, the relief of phimosis by operation, circumcision being performed if the parts are not too greatly swollen, light diet, hot baths, the administration of laxatives when required, and medicines calculated to subdue the fever, render the urine bland and slightly antiseptic, and control the painful erections. These indications should be met by aconite in small doses, boric acid, and potassium bromide. An excellent formula for a child of five years is the following:

℞

Potassii bromidi	ʒss to i
Acidi borici	gr. xlviii
Tinct. aconiti	gtt. xii
Tinct. belladonnæ	gtt. xxiv
Spts. ætheris nit.	fʒiii
Liq. potassii citratis	q. s. ad fʒvi

M. S. Dessertspoonful in water every two hours.

The penis should be kept wrapped in cloths wet in lead water and dilute alcohol.

On the subsidence of the acute inflammatory symptoms injections may be administered. These should contain the remedies used in similar conditions of the adult, but should be somewhat weaker, varying from one-half to two-thirds strength, according to the age of the child. They should never be used strong enough to cause acute or prolonged pain.

The injections should be administered immediately after the child urinates, from half a drachm to a drachm being thrown in each time. As soon as the fever subsides the internal administration of salol is serviceable. This may be given in doses of one to three grains six times a day, depending upon the age of the patient, and may be combined with balsam of copaiba or oil of sandal wood in appropriate doses. When the fever persists and assumes an irregular intermittent type full doses of quinine night and morning will be found serviceable.

Female Children.—In female children gonorrhœa takes the form of urethro-vulvovaginitis. It is different from the disease as it appears in the adult, since in the latter the vagina is only exceptionally involved. The catarrhal or irritative form must be distinguished from that due to the gonococcus.

Catarrhal vulvovaginitis may be caused by any irritant, such as prolonged contact of irritating urine or of fæces, lack of cleanliness, seat-worms, decomposing discharges incident to exanthemata, etc. The inflammation is usually confined to the vulva, the vagina being but slightly involved, and the urethra escaping entirely.

The symptoms are those of ordinary inflammation, as heat, redness, swelling, pain, or itching, increased by contact with urine. There are often extensive excoriations, or even distinct ulcers.

The diagnosis is founded on the absence of gonococci and on the presence of vast numbers and varieties of other microörganisms, the comparatively mild course of the affection, though it may be extremely chronic and rebellious to treatment, and the absence of involvement of the urethra and vagina. The prognosis is good.

The treatment consists in removal of the cause and in strict local cleanliness. Since this affection is very commonly associated with seat-worms, these should always be searched for. Mild antiseptic washes, as boric acid, followed by dusting powders, such as finely powdered bismuth or zinc oxide, and the application of a thin layer of cotton between abraded and inflamed surfaces,—*i.e.*, between the greater and the lesser lip of each side,—usually result in cure. When the disease becomes chronic, stronger astringent injections and washes are required.

Gonorrhœal Vulvovaginitis.—This is an affection which recent studies have shown to be much more prevalent and serious in its ultimate effects than has generally been believed.

Cause.—In the new-born and in young infants gonorrhœal vulvovaginitis is acquired from the mother, either from direct contagion during parturition, or more mediate contagion later through the agency of towels, wash-rags, fingers, etc. When it develops after the nursing period it is usually due to mediate contagion. Thus, it has been shown that when one case is introduced into an institution the disease spreads rapidly, probably by the medium of the bath or towels. The genital mucous membrane of the child seems to be exceedingly sensitive to the gonococcus. Exceptionally vulvovaginitis is caused by criminal practices. When these are suspected, and consequently when there is a possibility of a medicolegal contest, the presence of the gonococcus should always be confirmed by culture on artificial media.

Symptoms.—These are pronounced. The discharge is free, purulent, often blood-stained. It comes from the urethra, vagina, and vulva. There are great swelling, intense hyperæmia of the mucous surfaces, which bleed readily when touched, pronounced ardor urinæ, and marked and persistent fever. There is often bitter complaint of severe abdominal and pelvic pain. On rectal examination the womb may be found tender and swollen.

The diagnosis is founded on the presence of gonococci, the involvement of the urethra, and the severity of the symptoms.

The prognosis is good. None the less, cases of peritonitis and death have been reported, and on the basis of apparently clear clinical records it has been shown that this inflammation in infancy may occasion imperfect development.

of the genitalia, sterility, and chronic invalidism in later life. The local conditions are apt to be rebellious to treatment.

Treatment.—In the early stages of the disease, when the symptoms are very acute, the child should be kept in bed, or at least her activity should be lessened. Polyvalent stock bacterins seem to be the most powerful means at our disposal for overcoming this infection. They should be given in doses of two to ten million at intervals of from four days to a week, in the absence of reactions. In connection with this treatment the genitalia should be kept clean by simple external lavage. Should bacterins not be available, or should they fail to produce a cure after two to six months' use, vaginal irrigations should be employed. These are to be given by means of a soft-rubber catheter inserted into the vagina. Any of the solutions suitable for use in the bladder may be used; those in most favor are potassium permanganate, protargol, boric and salicylic acids (ten grains of the first and five of the second being used to the ounce), and carbolic acid (1 to 200). These lotions act better if they are preceded by a cleansing douche of 1 per cent. sodium bicarbonate. Irrigations and topical applications do most good in the older children; as puberty is approached, and after that time, they are preferable to bacterins.

If these injections cause pain they must be weakened until they are borne well. As the acute stage passes they are gradually strengthened, hydrastis being added. For the accompanying urethritis small doses of salol and boric acid are indicated; the prescriptions given on page 198 can be advantageously used.

The general health should receive careful attention, and in strumous or cachectic patients treatment may have to be prolonged for weeks or months before cure is effected.

CHAPTER XII

COMPLICATIONS OF GONORRHŒA

In the large majority of patients suffering from urethritis, when treatment has been judiciously instituted from the beginning of the attack, there are no complications; that is, the disease is limited to the urethra, or to the urethra and prostate. Exceptionally the inflammation exhibits a tendency to extend wide of the urethra, or even to attack other parts of the body. In these cases there is often a mixed infection, the ordinary pus microbes being present and producing either local inflammations or a mild or severe form of septic poisoning, though there is evidence that the gonococcus in itself or the poisons engendered by it may produce many of these complications.

There is an individual susceptibility toward the development of complications, some patients never passing through a simple, uncomplicated attack.

As to the cause of complications, all factors which tend to exacerbate an attack of gonorrhœa predispose to complications. The fact that some of these complications may be due to a mixed infection should be borne in mind as indicating the necessity for perfect cleanliness in all local manipulations.

In the male the complications caused by gonorrhœa are: (1) balanitis and balanoposthitis; (2) phimosis and paraphimosis; (3) lymphangitis and lymphadenitis; (4) folliculitis and periurethral abscess; (5) cowperitis; (6) prostatitis (so common that it is hardly proper to call it a complication); (7) vesiculitis seminalis; (8) epididymitis.

Both sexes are subject to: (1) cystitis; (2) ureteritis and ureteropyelitis; (3) conjunctivitis; (4) metastatic gonorrhœa, including such manifestations as arthritis, endocarditis, and meningitis.

Balanitis and Balanoposthitis.—Though gonococci seem to play no *rôle* in the production of balanitis, or inflammation of the surface of the glans penis, this is a frequent complication of gonorrhœa.

The symptoms, diagnosis, and treatment have already been described, the gonorrhœal form of the affection running a course which does not differ from that due to other causes (see p. 108).

Phimosis, inflammatory in character and secondary to balanoposthitis (Fig. 115), has been described (see p. 98). This is always a troublesome condition, since it materially interferes with treatment and may render the diagnosis exceedingly difficult. Swelling may become so great that a certain amount of sloughing occurs. The inflammatory induration usually entirely disappears. It may remain, leaving a thickened prepuce, which is readily fissured and eroded.

If the patient first comes under treatment with a vague history and with an œdematous swollen prepuce from the orifice of which flow blood and pus, it is sometimes difficult to determine correctly the source and nature of the discharge.

Whether or not all the discharge comes from the preputial sac or a part of

it from the urethra can be ascertained by having the patient urinate after the preputial sac has been thoroughly cleansed by careful syringing.

Paraphimosis.—This is dependent upon inflammatory swelling of the foreskin, due either to balanoposthitis or to the urethral inflammation (Fig. 116), which, after rolling back or being forced back, can no longer be brought for-

Fig. 115.—Gonorrhœal phimosis.

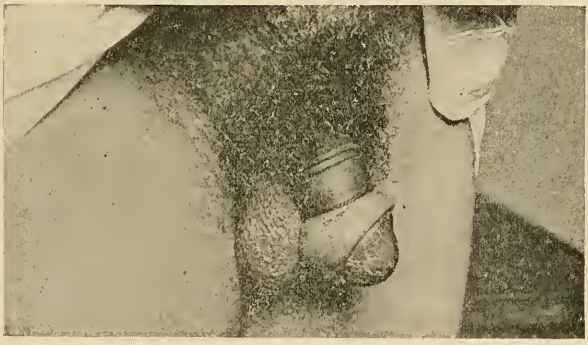


Fig. 116.—Gonorrhœal paraphimosis.

ward. The question of differential diagnosis is scarcely raised here, since the urethral meatus is freely exposed and the discharge can be seen escaping through it. The treatment has been described (see p. 102).

Lymphangitis.—In a small percentage of gonorrhœal cases a simple lymphangitis or inflammation of the lymphatic vessels occurs.

The complication arises sometimes in cases of little severity, but usually when the urethral inflammation is unusually acute. Cleanliness and the avoidance of dressings which prevent the escape of pus from the urethra are the prophylactic measures to be employed.

Lymphadenitis or Bubo.—Inflammation of the inguinal nodes, or bubo, is a comparatively rare complication of gonorrhœa.

It is commonly excited by excesses, exposure, or violent and long-continued exertion. Persons who are much on their feet suffer more frequently from this complication than those whose occupation allows of more rest. The node usually affected is one of the superficial set lying just below Poupart's ligament, embedded in the subcutaneous cellular tissue and placed above the fascia lata.

Symptoms.—A small, painful tumor makes its appearance in the groin (Fig. 117); it is tender on pressure, and the pain is aggravated by standing

Fig. 117.—Bilateral gonorrhœal buboes.

Fig. 118.—Periurethral abscess; marked swelling of prepuce.

or walking. It is at first freely movable beneath the skin, but afterwards contracts adhesions to the latter and to the surrounding parts, and becomes doughy in feel and reddened or purplish in hue. The majority of these cases after reaching this condition will subside under appropriate treatment, disappearing in time. In some instances, however, particularly in patients of scrofulous tendencies or in those whose vitality is lessened through bad habits or overwork, suppuration ensues, ushered in by the local and general phenomena of abscess-formation. The discharge from a suppurative gonorrhœal bubo does not contain gonococci.

The treatment is that of adenitis from other causes (see p. 129). Complete removal of gonorrhœal buboes before they have broken down is justifiable, provided they become progressively worse in spite of one or two days' careful treatment.

Folliculitis and Periurethral Abscess.—Gonorrhœal inflammation not only spreads along the surface of the urethra, but, dipping into the mucous

follicles and gland ducts, involves their entire mucous surface. Often if the finger is passed along the under surface of the urethra there can be felt distinct nodulations, due to the follicular swelling. At the meatus, where the glands and follicles are especially well developed, pus may be seen to escape from their orifices on pressure.

If the ducts become closed from swelling or from inflammatory exudation, the catarrhal secretion of the follicles being no longer able to escape into the urethra, small pockets of pus, or follicular abscesses, appear. These follicular abscesses are most frequently located in the first inch of the urethra, the follicles being numerous in this region. They appear as small, round, tender nodules, which may open internally without involving the skin, the duct finally becoming patulous. Frequently, however, the skin reddens and is no longer movable over the nodule, and the latter discharges its contents externally. In this case the urethral opening of the gland usually remains closed, and no fistula results. The frænum is apt to be markedly œdematous during the period of pus-formation in the follicles lying near its point of attachment behind and below the meatus. On stripping back the foreskin the projecting swelling is readily seen entirely obliterating the normal depression situated at the side of the frænal attachment. When external rupture and discharge of pus take place, a troublesome sinus is often left.

Sometimes the lacuna magna remains in an inflammatory condition long after the urethral mucous membrane has returned to a healthy state. The opening of this follicle is so large that it is not readily obliterated, yet it may be narrowed to such an extent that healing injections do not penetrate to its deeper portions. Such an inflammation will occasion a long-continued discharge.

At the frænum the mucous follicles are surrounded by fibrous tissue: hence abscess-formation is limited. Farther back along the urethra this investment of connective tissue is less marked: hence the inflammation may readily extend into the cavernous tissue, and in case the inflammation goes on to suppuration, periurethral abscess will be formed.

Periurethral abscess begins as a case of folliculitis or adenitis, but the swelling rapidly increases, and is attended with pain, tenderness, and often some diminution in the size of the stream passed during urination. The swelling may suddenly subside from opening of the obstructed duct. This is usually denoted by diminution in the size and tension of the tumor, by blood and pus in the urine, and by a sense of relief from pain. The subsidence may inaugurate a speedy cure, or may be shortly followed by urinary extravasation. Commonly the skin becomes reddened and inflamed, and the pus is evacuated externally, after which the abscess-cavity heals (Fig. 118).

If the abscess opens externally and internally at the same time, a urinary fistula results, and one difficult to cure.

Periurethral abscesses occur at any portion of the anterior urethra, but are most frequently observed in the region of the bulb. They may be attended with considerable inflammatory induration of the corpus spongiosum, which may ultimately undergo complete resolution, or may remain permanently, constituting an incurable chordee and preventing intercourse.

When urinary extravasation occurs it is attended by rapid increase in pain and swelling, and infiltration of sometimes the greater portion of the corpus spongiosum. The local pain is much increased during each urination. There is commonly an opening formed externally, which allows of free purulent discharge and results in urinary fistula. Sometimes an extensive sloughing process is inaugurated, attended with well-marked general septic symptoms. Even in the mildest case of urinary extravasation there may be sufficient destruction of the erectile tissue of the spongy body to cause great deformity of the penis when the organ is erect.

Treatment.—Gentle pressure and massage are sometimes successful in rendering patulous the obstructed duct of an inflamed gland or follicle, or the purulent collection may be incised through an urethroscope. When the swelling becomes marked and painful, cloths wet with alcohol and lead water should be kept about the penis. When the skin becomes adherent and softening occurs, the follicles should be opened, curetted, and packed with iodoform gauze. They usually heal kindly from the bottom. When they have ruptured spontaneously, causing a troublesome sinus, this should be converted into an open wound, and be curetted and packed. When there are both internal and external openings, the formation of a permanent fistula is guarded against by permanent or intermittent catheterization, no urine being allowed to escape through the artificial opening. Fistulæ at times heal spontaneously. If not, a plastic operation is indicated.

When the lacuna magna becomes involved in a chronic inflammation, which, though not going on to abscess-formation, persists and keeps up discharge, a fine grooved director should be passed to its deepest part, and it should be slit out into the urethra.

Periurethral abscess when once formed demands immediate evacuation, and this indication is even more imperative when there is urinary extravasation. The formation of a fistula is guarded against by permanent catheterization.

Prostatitis.—Prostatitis exists in some degree in practically every case in which the posterior urethra is invaded. It is therefore to be regarded rather as one of the typical features of the disease than as a complication. The follicles and glandular elements of this body are the structures chiefly involved, the muscular tissue, forming the greater portion of its mass, remaining unaffected, except in the most severe cases.

Simple acute prostatitis represents the mildest form of acute prostatitis. It is probably present to a minor degree in every case of acute posterior urethritis, and represents little more than inflammatory hyperæmia.

Acute follicular prostatitis is usually due to some cause exciting renewed intensity of gonorrhœal inflammation, such as excessive drinking or coitus.

The patient complains of burning during urination, and sharp, shooting, clearly localized pains during the passage of the last drops. These pains are located in the deep urethra. On rectal examination the prostate is found to be not materially enlarged, but presenting one or two well-defined nodules, usually in one lobe only. These are intensely indurated, contrasting markedly with the soft condition of the remainder of the gland, and are painful on pressure. The inflammation is confined to the follicles and the perifollicular tissues.

Parenchymatous prostatitis, after it runs on to suppuration, is the most serious form of the affection. The whole structure of the gland is involved. There is not only great inflammatory hyperæmia, but also marked exudation. The constitutional reaction is pronounced.

The abscess usually ruptures into the urethra. This will be denoted by aggravation of the pain during the act of defecation or of micturition, followed by a free discharge of blood and pus through the urethra, and the immediate amelioration of all the symptoms. This is considered the most immediately favorable, and is the common termination; it may be followed by urinary extravasation, requiring operation, but this is unusual.

The pus may penetrate the capsule of the gland at any point. If it is not evacuated into the urethra, it is prone to rupture into the rectum. If it does not open into either the rectum or the urethra, it generally burrows into the perineum or the ischiorectal fossa. It may burrow in almost any direction, cases being recorded in which it opened through the sciatic foramen, at the edge of the false ribs, and into the abdominal cavity.

FIG. 119.—Epididymitis with hydrocele. Gonococci in small numbers were found in the ten cubic centimetres of slightly cloudy fluid removed from the vaginal sac. Pain was markedly relieved by aspiration of the fluid.

At times prostatic abscesses develop in so quiet a manner as to escape observation, with no symptoms other than those commonly noted in the congestive form of the disease, which may be so slight that the patient makes no complaint. After some days the symptoms of septic absorption, characterized by rigors and fever, set in; and examination by the rectum shows a large fluctuating swelling. Hence in all cases of urethritis attended by undue systemic disturbance, examination should be made to discover whether or not this insidious form of prostatic trouble is developing. (For symptoms, diagnosis, and treatment of prostatitis, see page 386, *et seq.*)

VESICULITIS.—Vesiculitis, or inflammation of the seminal vesicles, occurs as a complication of acute posterior urethritis in a much larger percentage of cases than is generally imagined, the symptoms differing so slightly from those of inflammation of the prostate that the involvement of the seminal vesicles is not suspected unless a rectal examination is made. (See section on Seminal Vesicles, p. 375.)

EPIDIDYMITIS.—From an anatomical consideration of the ejaculatory duct, vas deferens, and epididymis, it is easy to understand how by direct continuity inflammations of the prostatic urethra may travel to the epididymis.

Epididymitis rarely develops before the third week of gonorrhœa. Most of

the cases begin in the fourth or fifth week of the disease. It may occur within three days of the onset of urethritis or not till a gleet has run a course of several years.

It is due primarily to involvement of the posterior urethra in the gonorrhœal process; secondarily, to any cause which, by increasing the violence of this inflammation, may favor its extension to the ejaculatory ducts and the vas: neglect of treatment, venereal excitement, coitus, exposure to cold, drinking, and violent exertion, all the causes which aggravate posterior urethritis, also render more probable the onset of epididymitis. Irritating injections or instrumentation during the acute stage of a posterior urethritis frequently cause epididymitis. Of all these causes those most commonly operative are neglect of treatment and coitus.

The disease is usually unilateral, and seems to affect the two sides with about equal frequency (Fig. 119) (see section on "Epididymitis," p. 316).

EXTRAGENITAL AND SYSTEMIC GONORRHŒA

As a rule secondary to urethral infection in the same individual, gonorrhœa exceptionally affects structures other than the genital tract, by predilection those covered with columnar epithelium and by endothelium, as the rectum conjunctiva, peritoneum, synovial sheaths, meninges, peri- and endocardium, blood-vessels, and pleura. Though stratified pavement epithelium resists for a time gonococcal invasion, gonorrhœal cystitis and stomatitis are exceptionally observed.

Cystitis.—Until the nature of posterior urethritis was clearly defined it was common to attribute the symptoms attendant upon this inflammation to involvement of the neck of the bladder. The possibility of extension of posterior urethritis to the vesical mucous membrane cannot be denied, and any one of the many causes which aggravate the original disease may occasion such extension. The inflammation rarely spreads far from the internal orifice of the urethra, being usually limited rather sharply to the trigone. In the great majority of cases it is due to mixed infection, the gonococci themselves apparently not readily infecting the mucous membrane of the bladder. Involvement of the entire vesical mucosa is extremely rare. The subjective symptoms are so like those of posterior urethritis that on these alone a differential diagnosis can scarcely be made (see chapter on "Cystitis," p. 488).

This condition is difficult to cure, pathological alterations taking place in the vesical mucosa, and, indeed, in the whole thickness of the bladder walls, which are liable permanently to cripple this viscus.

The general treatment appropriate to acute posterior urethritis and to prostatitis requires no material alteration when it becomes clear that the vesical mucosa is involved in the inflammation.

Ureteritis, Pyelitis, and Nephritis.—These rare complications are the results either of direct extension of the inflammatory process, or of the gonococci being carried to the kidney by the blood, or possibly through the lymph-channels. An epididymitis is very often the source of hæmatogenous infection.

Ureteritis and pyelitis are usually associated, and are recognized by the examination of the urine obtained by catheterization. Symptoms may be

entirely wanting except for the persistent pyuria with recurrent attacks of urethritis, or there may be vague pain in the loin, or a history of distress in this region.

Nephritis probably results more often from hæmatogenous infection than from direct extension of the disease. The onset may be insidious or sudden, and the attack mild or severe. Many of the milder forms of the affection escape notice altogether, the only symptom having been a transient albuminuria. In the more severe cases there is marked prostration, with fever and the associated symptoms. There are pain and tenderness in the loin; local or generalized œdema may be present. The urine is at first reduced in quantity, and later increased.

Treatment.—Gonorrhœal nephritis calls for treatment similar to that suitable for nephritis from other causes. Cups and hot compresses to the loins are particularly indicated. Should pus form, a very rare circumstance, nephrotomy is demanded.

Pyelitis and ureteritis, whether the results of direct extension or a residual lesion of nephritis, are best treated by lavage by means of a small ureteral catheter with such solutions as are used in the bladder.

GONORRHŒA OF THE RECTUM.—Gonorrhœal inflammation of the rectal mucous membrane is observed more frequently in women than in men, mainly because women are more exposed to infection from the backward trickling of gonococcus-bearing secretions from the vulva and vagina. The disease can be excited by unnatural practices.

Symptoms.—The symptoms are those of acute inflammation. There are free discharge of blood-stained pus, tenesmus, painful defecation, and on direct examination acute redness and infiltration of the mucous membrane, with excoriations about the anal orifice. The disease is prone to become chronic, leaving on subsidence of the general inflammation one or more localized ulcers. These, if allowed to extend, may ultimately cause dense cicatrices.

The diagnosis is, of course, founded upon the presence of the gonococcus, together with a history of infection.

The treatment consists in relieving the tenesmus and burning pain of the early stages, in frequent cleansing of the mucous membrane of the affected surfaces, and in applying astringent and antiseptic medications.

For the relief of pain and tenesmus, suppositories containing a grain of the watery extract of opium, a quarter of a grain of cocaine, and a quarter of a grain of belladonna will be sufficient.

The rectum should be cleaned at least twice a day by means of a hot douche of corrosive sublimate 1 to 20,000, or protargol 1 to 1000, or, if these solutions occasion severe pain, by a saturated solution of boric acid.

When the acute symptoms have subsided, strong solutions of silver nitrate are employed, 1 to 1000 and 1 to 500, in smaller quantities. When the general catarrh is cured, leaving only ulcers or hyperæmic patches, these are touched directly with a strong solution of silver nitrate (ten per cent.), or with one of the other agents already mentioned in the treatment of chronic gonorrhœa.

In some cases, when a discharge persists, a two per cent. solution of alum or of tannin injected into the rectum will prove serviceable.

Gonorrhœa of the Mouth, though of exceeding rarity, has been observed as an acute stomatitis, in the discharges of which were found gonococci.

GONORRHŒA OF THE EYE

Gonorrhœal Conjunctivitis.—*Purulent Ophthalmia; Gonorrhœal Ophthalmia; Acute Blennorrhœa in Adults.*—This is a violent inflammation of the conjunctiva, characterized, in its usual form, by great swelling of the lids, serous infiltration of the bulbar conjunctiva, and the free secretion of contagious pus.

Cause.—The source of contagion can usually be traced to an acute gonorrhœa or gleet, or to an eye similarly affected, soiled fingers or linen being the usual means of transmission.

The gonococci of Neisser are present in great abundance during the purulent stage, being found within the cells. They penetrate the epithelium and enter the

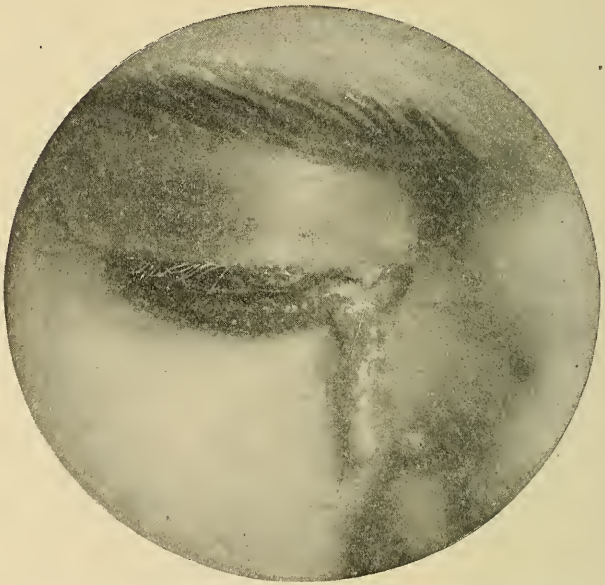


Fig. 120.—Gonorrhœal conjunctivitis. Swelling of the lids and free discharge.

lymph-spaces of the subconjunctival tissue. The secretion from vaginal leucorrhœa, which is not uncommon in young girls, may produce a conjunctivitis of very analogous type.

Symptoms.—The symptoms appear from twelve to forty-eight hours after inoculation, and at first resemble those of an ordinary catarrhal conjunctivitis. They speedily give place to great swelling of the lids (Fig. 120), intense congestion and chemosis of the bulbar conjunctiva, which forms a ring of infiltration around the cornea, and thickening of the palpebral conjunctiva, which becomes rough and dark red in color, and is dotted over with spots of ecchymosis (Fig. 121). The slightly turbid discharge of the early stage changes to a yellow or greenish-yellow pus, which is secreted in great quantities. The vitality of

the cornea is soon threatened, and, unless the disease is properly managed, ulcers form, either small, oval lesions near the margin of the cornea, or larger ones at its centre. These may terminate in healing, or perforation may take place. In the event of the latter mishap, incarceration of the iris in the wound and the formation of an adherent scar or leucoma result. This scar may bulge forward and form a partial anterior staphyloma, or, if the prolapse has been an extensive one, the whole cornea is involved, and the protruding cicatrix is known as a total staphyloma. In bad cases the inflammation travels through all the tissues of the eyeball, which passes into a state of general inflammation or panophthalmitis (Fig. 122), ending in atrophy and shrinking of the bulb.

Gonorrhœal ophthalmia neonatorum, due to gonococcic infection from the genital tract of the mother, has an incubation of two or three days and is often

FIG. 121.—Gonorrhœal conjunctivitis. Infiltration of bulbar and palpebral conjunctiva.

bilateral. The inflammatory symptoms are those characteristic of the infection in the adult, but less intense and rapidly destructive.

Gonorrhœal conjunctivitis reaches its height in about ten days, and then gradually subsides in from one to two months. Sometimes it passes into a chronic type of inflammation, with great redness of the palpebral conjunctiva and hypertrophy of the papillæ. One eye is usually first affected; the other may escape or may be subsequently inoculated; sometimes, however, both organs are simultaneously inflamed.

Diagnosis.—This acute infection must be distinguished from gonorrhœal rheumatic ophthalmia in the adult (see table, p. 240), and from chemical or traumatic conjunctivitis in the new-born incident to bichloride vaginal injection of the mother, or prophylactic silver instillations to the eyes of the infant;

the chemical conjunctivitis is rapid in onset, brief in course, and gonococci are not found in the discharge.

Prognosis.—This is always grave, and, unless the disease is treated from its incipiency, corneal scars, or the more serious sequelæ of perforation which have just been described, are likely to result.

Treatment.—Every case of true gonorrhœal conjunctivitis should be isolated. Patients suffering from gonorrhœa should be warned of the danger of infecting their eyes and the eyes of those around them. As usually one eye alone is affected, the other may be protected by sealing it with an antiseptic bandage the edges of which are made secure by fastening along them strips of gauze painted with flexible collodion, or by the application of Buller's shield, which consists of a watch-glass of the ordinary form fitted in a square piece of

Fig. 122.—Gonorrhœal conjunctivitis passing into a panophthalmitis.

rubber adhesive plaster, which is carefully applied to the brow, temple, lower margin of the orbit, and nose, and secured with additional strips to prevent the discharge from getting under the edges. The watch-glass is directly in front of the eye and permits its inspection. Great care must be exercised in applying this bandage, because if any of the discharge should be confined beneath it, or in any way should find entrance under the edges of the plaster, the chance of infection would be greater than without the bandage. Gonorrhœal conjunctivitis of the new-born is guarded against by instilling in each eye immediately after birth a few drops of a five per cent. solution of protargol or a one per cent. solution of silver nitrate. The curative treatment both in infants and adults is as follows: During the earlier stages *cold* is the most useful agent. This may be applied by means of Leiter's tubes, but it is more convenient to place upon a block of ice square compresses of patent lint, which in turn are

laid upon the swollen lids and as frequently changed as may be needful to keep up a uniform cold impression.

The discharge should be frequently removed. This may be done by irrigating the conjunctival cul-de-sac at intervals of not more than half an hour with a saturated solution of boric acid or a solution of bichloride of mercury 1 to 8000. It is a mistake to use strong solutions of sublimate in the treatment of this disease, because they increase the liability of the cornea to ulceration, and, moreover, it is not possible to employ them in such strength that the germicidal properties of this drug will be efficient.

Silver nitrate is the best of all remedies. The lids should be thoroughly everted without pressure upon the globe, the inflamed conjunctiva freed from all secretion, and a solution of this drug, five grains to the ounce, applied with a cotton mop or camel's-hair brush to the exposed surfaces, or simply dropped upon them. The lids are then returned to their place. This application is made once in twenty-four hours. In the more severe cases a drop of 1 to 500 silver nitrate should be placed in the eye every two hours.

If corneal haziness appears, or a central ulcer forms, atropine drops, four grains to the ounce, should be instilled every three or four hours; a marginal ulcer, with a tendency to perforate, may be treated in like manner with a solution of eserine, one-sixth to one-half grain to the ounce, or, as this drug, while it has distinct value in preventing sloughing of the cornea, tends to increase the hyperæmia of the iris and the tendency to the production of iritis, it may be used every four hours during the day and a drop or two of the atropine solution at night.

If the chemosis of the conjunctiva is very great, scarification may be tried, and will occasionally be beneficial. Great swelling of the lids, tending by their pressure to endanger further the nutrition of the cornea, may be relieved by canthotomy,—that is, by cutting through the external commissure of the affected eye.

During the stage of corneal ulceration, should it occur, the cold applications previously described may be substituted by hot fomentations applied by means of squares of antiseptic gauze wrung out of carbolized water of a temperature of 120° F. and frequently changed. These applications are useless unless they are really hot.

Many other drugs in addition to those named have been used for irrigating the conjunctival cul-de-sac. Of these, the most important are mercuric cyanide 1 to 1500, protargol 1 to 2000, hydrogen peroxide, aluminum sulphate eight grains to the ounce, carbolic acid one-half to five per cent., and potassium permanganate. Of the last-named drug a tepid solution 1 to 5000 should be prepared, and the conjunctival cul-de-sac freely flushed twice a day, at least one litre being employed at each irrigation. The irrigations are best given with the aid of a special *laveur,* although an ordinary irrigating apparatus is useful.

During the entire course of the treatment the lids should be kept greased with pure vaseline, which should also be freely introduced within the conjunctival cul-de-sac.

Depletion is sometimes practised, but, unless the indications for canthotomy are present, its value is questionable. The same may be said of the practice,

once common, of beginning the treatment by bringing the patients under the influence of mercury. Usually they are debilitated, and supporting treatment—quinine, iron, strychnine, and milk punch—is essential. If the pain is severe, there is no objection to the use of morphine or opium, the latter drug having a good influence on the sloughing process in the cornea.

Metastatic Gonorrhœal Ophthalmia.—This disease is occasionally seen during gonorrhœa, and does not depend upon the introduction into the eye of infecting material from the urethra. It is apt to occur in patients who suffer from articular complications. It is bilateral, mild in character, and resembles a moderate catarrhal conjunctivitis. Sometimes iritis complicates it.

The treatment is that of conjunctivitis or iritis from other causes. Bacterins are sometimes serviceable.

Virulent Gonorrhœal Conjunctivitis.	*Rheumatic Gonorrhœal Ophthalmia.*
A rare but serious affection.	More common but less serious.
Essential cause is inoculation with gonorrhœal pus from without; violently contagious; gonococci abundant in pus.	Probably the causative agent comes from within through the blood. Probably metastatic; gonococci not found except in the later stages and then with difficulty.
Not dependent on or necessarily coincident with rheumatoid affections.	
May affect subjects not afflicted with urethritis, as in infants (ophthalmia neonatorum).	Is coincident with gonorrhœal arthritis.
Usually affects only one eye, but may be transferred to the other.	Occurs only in patients with gonorrhœal urethritis.
The conjunctiva is always the structure primarily involved.	Commonly the disease is bilateral in the beginning; or rarely may move from one eye to the other.
	Disease usually starts in the iris membrane of Descemet and may later involve the oculo-palpebral conjunctiva.
No tendency to recur in subsequent urethritis.	Marked tendency to recur.
Prognosis extremely grave; often loss of the eyesight.	Prognosis favorable; no loss of eyesight.
Treatment must be specific and active.	Treatment need be only symptomatic.

The epidemic conjunctivitis due to the Koch-Weeks bacillus or to the pneumococcus affects both eyes with but moderate severity, is usually observed in more than one member of a family and fails to show gonococci in the moderate discharge.

Gonorrhœal Rheumatism, or Metastatic Gonorrhœa

Gonorrhœal rheumatism, a local expression of gonococcic septicæmia, commonly affects the joints. It may, however, involve the bones, tendons, nerves, bursæ, pericardium, endocardium, and meninges of the cord. It is due to systemic poisoning by the specific microörganisms or by the ordinary bacteria of suppuration and the toxalbumens formed by these germs. When it is caused by gonococci carried from the urethra or from a wound into the circulation and lodged at remote points, the inflammation is fibrous and adhesive in type.

Finger in a fatal case of gonorrhœal rheumatism discovered gonococci in the

vegetations of the endocarditis. There was also myocarditis, due to the presence of these germs.

When there is free pus-formation the ordinary pyogenic microbes are found.

The disease may begin before the third week of the urethritis, though it commonly develops much later.

In the order of frequency the knee, ankle, wrist, and elbow are the joints commonly involved. Usually more than one joint is inflamed at a time, though in about one-third of all cases the disease is monarticular.

It develops in about two per cent. of all cases of urethritis, and is far more frequently observed in men than in women. It may complicate gonorrhœa of any mucous surface,—the conjunctiva, for instance.

Arthritis is the commonest manifestation of gonorrhœal rheumatism. It may be ushered in by general rheumatic pains, but more commonly is characterized by rather sudden swelling, pain, tenderness, and redness of the affected articulation. There is synovial exudation, with fixation of the joint in the position which most relaxes its synovial investment. There is moderate fever. Pain is severe.

These acute symptoms usually last for several days. The fever then subsides, and complete resolution may quickly follow, or the patient may suffer for weeks or months from swelling, tenderness, and harassing pain, subject to occasional exacerbations in accordance with the condition of the urethra. Such joints commonly remain partly or completely stiff. Rarely suppuration takes place, characterized by constitutional and local symptoms of pus-formation, resulting, if the patient recovers, in ankylosis of the joint.

Fig. 123.—Subacute gonorrhœal arthritis of knee.

Sometimes the chronic inflammation produces a condition of hydrarthrosis, attended with limitation of motion, but otherwise causing little pain and but slight disability. The effusion usually undergoes absorption. Occasionally it lasts for weeks or months, causes stretching of the ligaments, and finally preternatural mobility and profound alteration in the joint.

Symptoms.—There is absolutely no characteristic feature of the joint affection which will enable the surgeon, from a local examination, to distinguish gonorrhœal inflammation from that caused by other infections. In making a diagnosis, however, the following points should be borne in mind. In gonorrhœal "rheumatism" there is a preceding history of urethritis, and the severity of the rheumatic attack varies in proportion to the exacerbations and remissions of the urethral inflammation. The disease rarely pursues the acute course observed in ordinary "rheumatism," but rather has a tendency to become chronic, and after it has once occurred is prone to relapse in case of new infection of the urethra (Fig. 123).

The distinction between gonorrhœal arthritis and that due to " rheumatism " is exceedingly difficult to make. In the former case, however, but few joints are involved at one time, rarely more than two or three, and in these the inflammation does not appear synchronously, but one inflames after the other. The involvement of more than one joint is the rule in gonorrhœa rather than the exception. The fever is never very high, except in the rare cases when suppuration occurs, nor is sweating so pronounced a symptom as in rheumatism. The gonococcus complement-fixation test is positive.

Occasionally the gonorrhœal " rheumatism " takes the form of periarthritis The symptoms are much the same as those of arthritis, except that there is no exudation into the joint-cavity, and the redness, œdema, pain, and tenderness are more marked. It commonly terminates in resolution, but may cause ankylosis.

Prognosis.—In the great majority of cases permanent damage does not result from the disease, though in the more severe infections, and when the disease is treated improperly, stiffness or even ankylosis may result.

Treatment.—For the satisfactory treatment of gonorrhœal arthritis it is necessary that not only the disease in the joint be cured, but that the focus of infection be eradicated, that a recurrence of the disease in the same joint, or the infection of additional articulations may be avoided. The eradication of the focus of infection may imply prostatic or seminal vesicular drainage, the cutting of a stricture, or a more conservative treatment.

The treatment of the joint itself may be divided conveniently into expectant or nonoperative treatment, surgical treatment, and physiological or biological therapy, including, in the last, Bier's hyperæmic treatment, and serum and bacterin therapy.

Expectant Treatment.—This consists in putting the part at rest, by splinting and traction (confining the patient to bed where needful), protecting it from cold, and applying various lotions and ointments. Of the former the most useful, provided surface chilling is not distressing, are a saturated solution of magnesium sulphate and equal parts alcohol and lead water; of the latter, one composed of equal parts ung. hydrarg., ung. belladonna, ung. iodi comp., and petrolatum is serviceable. Baking at a temperature of 250 to 300° F. for fifteen to twenty-five minutes once a day or once in two days is helpful in subacute and chronic cases. Internal medication is useless, with the possible exception of calcium sulphide, by the use of which in enormous doses, sufficient to impart its odor to the breath, good results are reported to have been secured.

Surgical Treatment.—Aspiration is the simplest of these procedures, and is indicated when there is a considerable amount of fluid in the joint. The skin should be pierced with a tenotome before inserting the needle, in order to avoid infection. The injection of 5 to 20 c.c. of 2 per cent. liq. formaldehyde in glycerine after aspiration of the contained fluid, as recommended by Murphy, with the application of extension in order to keep the articulating surfaces separated, gives good results, but causes great pain.

Arthrotomy, with irrigation of the joint through the incision with carbolic acid (1: 500 to 1: 100) or similar lotion, has given good results, but on account of the danger of engrafting an additional infection should be reserved for cases of the greatest severity. Even when the synovia is purulent, the first time

arthrotomy is performed on a joint the wound should be closed without drainage.

Physiological and Biological Therapy.—Bier's Hyperæmia.—This is applied by wrapping a light rubber bandage about the limb sufficiently tight to lessen the flow of venous blood without interfering with the arterial circulation, thereby causing the tissues to contain an increased supply of blood (Fig. 124). The bandage should not be tight enough to cause pain, mottling or coldness of the part, and should be worn for long periods of time, ten hours twice a day, with intervals of two hours between the applications; or shorter applications may be used if deemed advisable. In addition to the benefit derived from the increased supply of blood, some degree of auto-vaccination is probably produced by the hyperæmia.

Serum Therapy.—The administration of antigonococcic serum, prepared after the method devised by Rogers and Torrey, is useful, particularly in the more acute stages of the disease, though in many cases the more chronic forms also react well. The serum is injected in doses of 2 c.c. every other day, or at longer intervals should reactions occur. In the absence of either reactions or improvement, after three or four doses, the amount injected may be doubled or tripled. If improvement is not secured with four to six doses the method should be abandoned as useless.

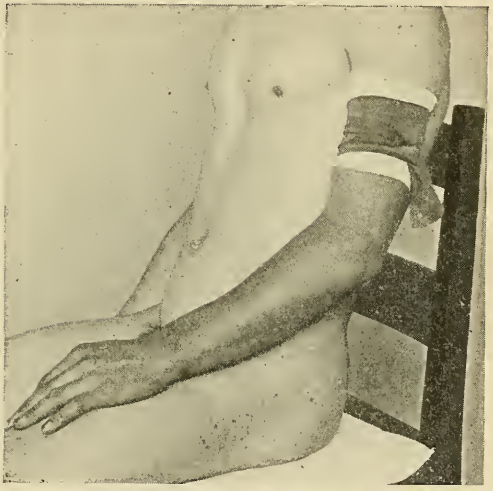


FIG. 124.—Bier's hyperemic treatment of elbow and wrist.

Bacterin Therapy.—This is probably the most generally applicable method of treatment. It may be used in either the acute or chronic stages, though the most brilliant cures have been effected in the latter. While some men have obtained the best results by the use of enormous doses, five hundred million to a billion, it is better to start the treatment with small doses, 20 to 50 million, gradually increasing the dose as indicated in the chapter on Bacterin Therapy.

EXOSTOSES.—Baer calls atention to an affection characterized by a painful bony outgrowth from the tubercle of the os calcis (Fig. 125), lying just in front of the attachment to the plantar fascia. Pain, the chief symptom, is referred directly to the attachment of the plantar fascia with the os calcis, and is elicited only by pressure. The patient usually walks on the ball of the foot. The affection appears in young males in the first year of a chronic gonorrhœa. It is bilateral. The diagnosis is based on the radiogram. Treatment is by operation and removal of the bony outgrowth and is entirely successful. This condition of painful overgrowth has been encountered in men who have never had a urethral infection.

TENOSYNOVITIS.—This affection develops usually after the acute stage of gonorrhœa has passed. The involved tendon exhibits over its course tenderness,

redness, œdematous swelling, and crepitation or distinct fluctuation. The tendons most commonly involved are the extensors of the fingers, the flexor of the thumb, and the tendons of the toes.

Pericarditis, Endocarditis, Pleuritis, and Meningitis are rare complications of gonorrhœa. Their treatment is that of similar conditions of other etiology, with the addition of serum and bacterins, which are useful in some cases, and should be given a cautious trial.

Phlebitis.—Heller notes that gonorrhœal phlebitis is commonest in men in the fourth or fifth week of a first attack. The internal saphenous vein is

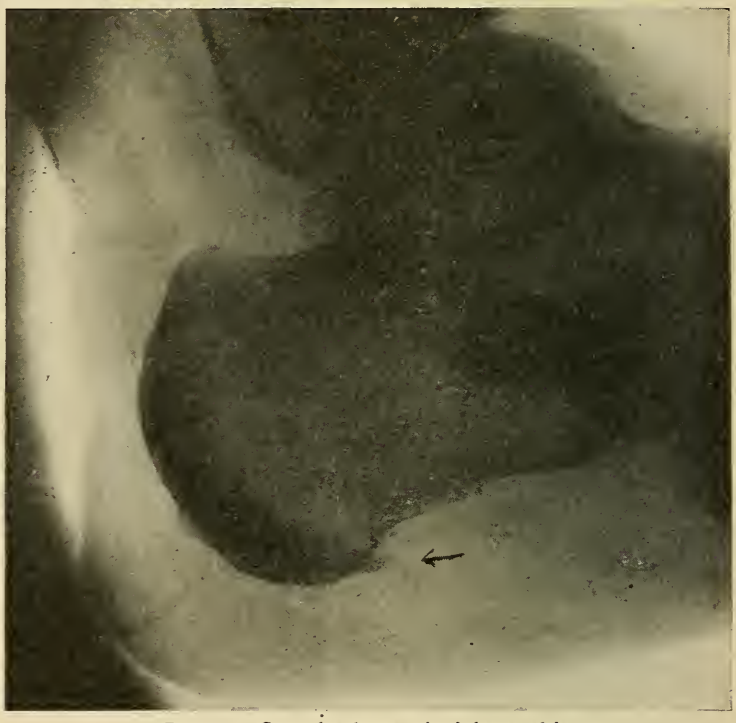


Fig. 125.—Gonorrhœal exostosis of the os calcis.

most frequently involved; next the common femoral, the superficial veins of the abdominal parietes, the veins of the corpora cavernosa, sometimes those of the arm. There are acute pain and fever. Until the external veins are involved, forming indurated cords, the diagnosis cannot be made. Two out of the twenty-six cases died,—one of embolus and one of sepsis. One required amputation at the thigh. The treatment is by rest, evaporating lotions, and later by absorbents.

Diagnosis.—The gonococcic nature of such affections as pericarditis, pleuritis, and meningitis can be determined only by the discovery of these organisms in the blood, even though a gonococcal urethritis be present. This requires the removal by venopuncture of about twenty cubic centimetres of blood and its immediate culture, since the diplococcus intracellularis meningitidis, the micrococcus catarrhalis, and some others decolorize by the Gram method.

CHAPTER XIII

STRICTURE OF THE URETHRA

A STRICTURE is a temporary or permanent narrowing of the urethral canal, caused by muscular spasm or by organic changes in the tissues which make up its walls.

Strictures may be congenital or acquired.

Congenital stricture is extremely rare, except at the meatus or in its immediate vicinity. Even these narrowings are often the result of infantile balanoposthisis, and thus not really congenital. A narrowing of the meatus, reducing it almost to pin-point size, may exist from birth without giving rise to appreciable difficulty, and, unless some urinary symptoms appear, may escape notice; the more severe grades should be treated by meatotomy.

The normal narrowing at the meatus is of physiological importance in favoring the projection of a strong, smooth stream of urine and the vigorous ejaculation of the sperm: hence free division of the meatus should not be advised on insufficient grounds. Not infrequently the operation may leave the patient with an artificial balanohypospadia and diminished projectile force. Congenital strictures should, however, be operated upon promptly when urinary symptoms arise which reasonably can be traced to them, or when they interfere with the proper treatment of more deeply seated morbid conditions of the urethra or of the bladder.

Acquired stricture is classified in accordance with its pathology under these general headings:

1. INFLAMMATORY.
2. SPASMODIC.
3. ORGANIC: (*a*) of large calibre; (*b*) of small calibre.

1. **Inflammatory stricture** is due to an acute catarrhal inflammation with recent soft exudate, causing swelling of the mucous membrane and encroachment on the urethral calibre. It is of short duration, and never causes retention, except when complicated by muscular spasm. It is often the first step in the formation of organic stricture.

Treatment.—The treatment is that appropriate to acute anterior urethritis. The term inflammatory stricture is misleading, since some authors thus designate true organic strictures,—*i.e.,* those which ultimately result from chronic inflammation with formation of fibrous tissue.

2. **Spasmodic stricture** is a temporary narrowing or obliteration of the urethra, due to contraction of the involuntary or voluntary muscles investing it. This contraction is either reflex or psychical in its origin; the compressor urethræ is usually the muscle at fault.

Reflex muscular spasm commonly depends on irritation transmitted from some hyperæmic point of the urethra, as from the actively inflamed mucous membrane of the posterior urethra, or from a patch of granular urethritis situated in or near the bulb. More rarely it may arise from irritation at a greater

distance, as from fissure of the anus, hemorrhoids, worms, cancer of the rectum, etc.

Among the causes of spasm may be mentioned strongly acid or irritating conditions of the urine, as in cantharidal poisoning or the uric acid diathesis, and urethral hyperæsthesia from sexual excess. Organic stricture is the usual predisposing factor in the development of the symptoms of spasmodic stricture.

The retention of urine incident to overdistention of the bladder, or acute fevers, or surgical operations, especially those upon the anus and the rectum, is probably at times the result of vesical inhibition, although it is usually attributed to urethral spasm.

Numerous cases have been reported in which a more or less persistent spasm has been attributed to a small meatus, since cure followed meatotomy; but it must be remembered that spasmodic stricture is particularly apt to occur in nervous, excitable, irritable young men, allied in type to hysterical women, and that in such patients any marked mental impression may cause a disappearance of existing symptoms. If the meatus is too small to admit a good-sized sound, in the presence of otherwise inexplicable urinary symptoms a cutting operation is clearly indicated.

Spasmodic stricture due to psychical cause is instanced by the inhibiting effect which shame or even a sense of hurry exerts over the function of micturition.

Diagnosis.—The diagnosis of spasmodic stricture is founded upon the sudden onset of either dysuria or retention of urine without inflammatory symptoms and without preceding symptoms of urethral obstruction. Sometimes the stream is irregularly interrupted, a condition designated as stuttering micturition. The introduction of a full-sized metal instrument may be resisted at first, but on gentle continued pressure the contracted muscles may be felt to yield and the instrument readily slips into the bladder.

Treatment.—The treatment of spasmodic stricture varies in accordance with the cause. When symptoms recur, careful search always should be made for organic stricture; this, if cured, will be followed by disappearance of the tendency to spasm. Every pathological condition about the genitalia or rectum should be corrected, and in the absence of contra-indications full-sized sounds should be passed at regular intervals.

When spasmodic stricture is complicated by retention, the patient should be put in a hot general bath (106° to 110° F.), and directed to urinate while therein. A hot sitz-bath is equally efficacious, but should be continued not over fifteen minutes. If at the end of this time the bladder has not been emptied, the patient should be thoroughly dried, put to bed, and given suppositories containing opium and belladonna, or hypodermic injections of morphine. These palliative measures should, however, never be persisted in when the bladder is greatly distended—*i.e.*, is readily perceptible on suprapubic percussion. The possible remote effects of overdistention of the bladder are far more to be dreaded than the slight discomfort attendant on the passage of an instrument: hence if the distention is great and the hot bath fails to give relief, catheterization should be practised at once. A soft rubber or an English catheter should be used first; if these fail, a metal instrument should be introduced. It must

be borne in mind that under these circumstances the bladder is peculiarly liable to become infected; therefore the catheterization must be practised with the observance of all the antiseptic precautions customary in major operations. The surgeon's hands must be thoroughly cleansed, the instrument sterile, the glans and meatus disinfected, and the anterior urethra previously flushed out with an antiseptic solution.

3. Organic Stricture.—This, in the vast majority of cases, is due to a preceding urethritis or to traumatism, though a chancroid, chancre, or ulcer due to lodgement of a foreign body may subsequently be followed by cicatricial narrowing. Gonorrhœal urethritis is by far the most common cause.

Organic stricture may occur in persons of any age, but is most frequent between the ages of twenty and forty-five. Women are not entirely exempt. Gonorrhœal stricture is said to occur less frequently in negroes than in white men. The longer the duration of the attack of gonorrhœa the more liable is the patient to have a stricture. The intensity of the attack is also of some importance in this regard. The supposed development of stricture because of too rapid cure of gonorrhœa is a popular myth; the more speedy the cure the less likely are strictures to form, nor have strong irritating injections any effect on the production of stricture unless they cause complications, such as abscess, or prolong the inflammation.

The rapidity of stricture development is dependent upon the nature of the original lesion. In case of rupture of the urethra narrowing of the lumen of this canal begins from the time the wound cicatrizes; that is, usually within a few weeks. In the case of gonorrhœa, however, the process is much slower. The infiltration caused by this disease, unless complicated by periurethral abscess, is essentially chronic. It is always a matter of months, and usually of years, before this infiltration undergoes sufficient organization to encroach seriously upon the calibre of the urethra. It may be said in general terms that a stricture rarely develops within one year of the beginning of an attack of gonorrhœa. Guyon holds that the greatest number of strictures occur four to ten years from the beginning of the original urethritis.

Prolonged erection, excessive coitus, and masturbation have been regarded as competent causes of stricture, especially by the ardent believers in strictures of large calibre, who find this lesion in nearly every urethra, often without a history of gonorrhœa or of any of the sources of irritation previously mentioned. Theoretically stricture is possible from such causes, but practically it is of the greatest rarity.

Traumatic stricture follows such wounds and contusions of the perineum as have caused partial or complete laceration of the urethra. Kicks in the perineum, falls astride of a resistant body, and fractures of the pelvis often cause such ruptures. "Fracture of the penis,"—that is, a sudden twist or bend of the erect penis, which causes subcutaneous rupture of the erectile tissue; "breaking a chordee,"—*i.e.*, violently straightening the curve incident to the inflammatory infiltration of the urethra and periurethral tissues; injuries due to the rough and clumsy use of urethral instruments; surgical treatment of previously existing strictures, such as incision, excision, cauterization, and electrolysis,—all these causes may produce traumatic strictures.

CLINICAL FORMS OF STRICTURE

The strictured part of the urethra varies greatly in extent, from a mere diaphragm-like band, *linear stricture* (Fig. 126), to one slightly broader, *annular stricture* (Fig. 127), and from that to a contraction which may involve two or three inches of the canal, changing it into a devious, irregular channel, *tortuous stricture* (Fig. 128).

Strictures may also be classified as: 1. *Soft or recent,* the subepithelial exudate not yet having become extensively organized into connective tissue. They are of large calibre. 2. *Cicatricial,* characterized by an ill-defined mass of fibrous tissue often cartilaginous in consistency. The traumatic strictures are made up entirely of fibrous tissue; the gonorrhœal strictures still exhibit traces of the original structure of the parts.

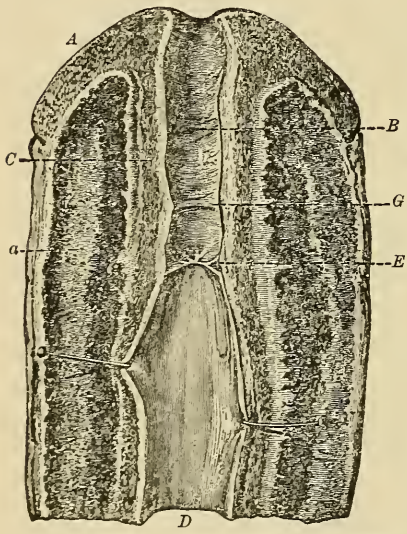


FIG. 126.—Linear strictures. *A*, glans; *B*, glandular urethra; *C*, spongy body; *D*, urethra dilated behind the stricture; *E*, linear stricture; *G*, linear stricture less developed; *a*, cavernous body. (Voillemier.)

There is also a peculiar form of contraction of the meatus, which appears as a diffuse induration of the mucous membrane, scar-like in appearance and cartilaginous in consistency; this extends outward on the glans and for some distance inward; it is apparently a form of scleroderma. Local treatment is of little use, but there is often some spontaneous improvement after a considerable lapse of time.

Strictures are further classified as,—

1. *Simple,*—that is, exhibiting only the symptoms and reactions characteristic of the majority of strictures.

2. *Irritable.*— Instrumentation causes unusually severe pain, is sometimes followed by hemorrhage, and excites undue local inflammation or occasions urethral fever.

3. *Resilient, Contractile, or Recurring.* —The stricture if untreated steadily becomes tighter. Even if it can be dilated, it again contracts so rapidly that this method of treatment is without benefit.

In accordance with the extent to which they narrow the urethra, strictures are either of *large calibre* or of *small calibre.*

The terms *permeable* and *impermeable* indicate whether or not an instrument can be passed through the narrowing.

Every stricture following a urethritis must at some time have been a stricture of large calibre, but just when such a stricture becomes a pathological factor and is able to give rise to symptoms is an unsettled point. There is no fixed calibre of the urethra, and the size of the meatus is not a reliable index as to the diameter of the canal behind it. The circumference of the flaccid penis affords the best indication as to the size of the urethra, the calibre of this canal

increasing in proportion to the growth of the penis; but the ratio is only approximate and is liable to variation.

The increased friction and resistance resulting from even a slight fibrous periurethral deposit may disturb the equilibrium which has been established and maintained between the usual efforts and power of the bladder as an

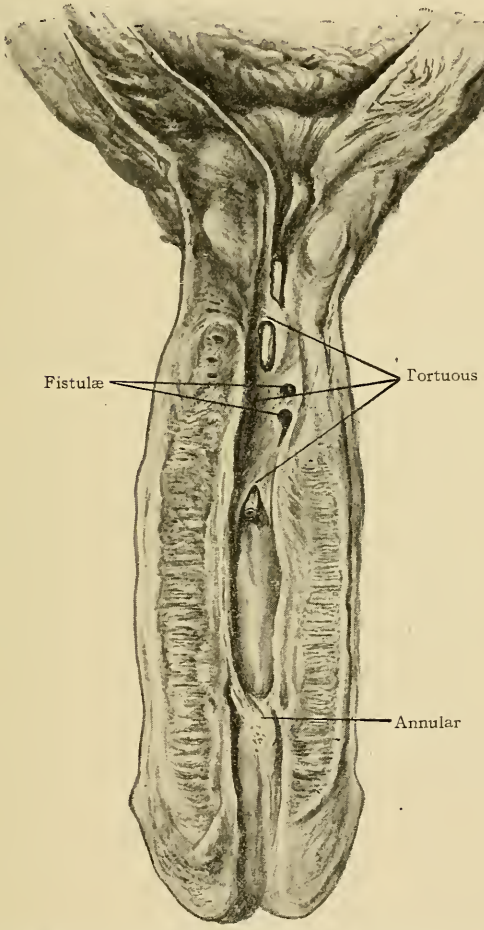


FIG. 127.—Strictures of the urethra. Illustrations of both the annular and tortuous types of the disease; so tight had the tortuous or posterior of the two become that fistulæ formed. (Laboratory of Pathology, University of Pennsylvania.)

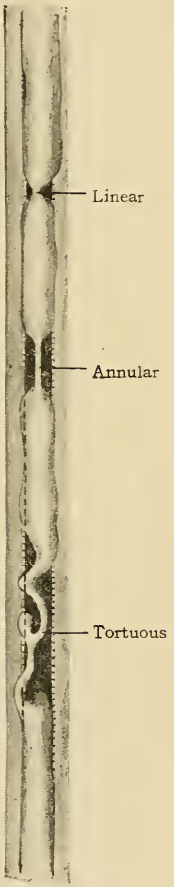


FIG. 128.—Diagrammatic representation of the three common varieties of urethral stricture.

expulsive organ and a certain average of resistance which must be overcome before it can empty itself. As a result the bladder becomes irritable, and is often rendered still more so by inflammation of the posterior urethra incident to backward extension of the catarrhal process usually active at the seat of narrowing. Thus is caused one of the most constant of the stricture symptoms,—*i.e.*, frequent urination.

The imperfect closure of the tube occasioned by the inflammatory infiltrate,

which prevents the urethral walls from being pressed tightly to each other by their investing layer of involuntary muscle, causes imperfect expulsion of the last drops of urine, and produces another characteristic symptom,—dribbling at the end of micturition.

The retention and decomposition of these last few drops, together with the abnormal friction between the stream of urine and the urethral walls at the site of narrowing, cause a subacute inflammation of the mucous membrane, accompanied by a catarrhal or mucopurulent gleety discharge.

Pain is developed in the lumbar and hypogastric region by reflex irritation transmitted from the area of inflammation and from the irritated bladder.

Where the urethral calibre is markedly diminished, the relation between causes and effects is, in the main, as just stated. As to how far the narrowing must go before such symptoms are excited, no dogmatic assertion can be made. Otis has promulgated a scale of relation between the calibre of the urethra and the circumference of the flaccid penis, any departure from which he regards as an evidence of the existence of stricture. This scale doubtless represents accurately the distensibility of the male urethra, but it does not represent what can fairly be called its normal calibre. The variation in size and dilatability of the different parts of the urethra has long since been clearly demonstrated by Delpet, Guyon, Sappey, and many others.

Otis, however, in effect assumes that the urethra should be a tube of uniform calibre, at least anterior to the triangular ligament, and the instrument which he has devised,—the urethrometer,—when used under the guidance of his tables, will detect apparent strictures in the majority of normal urethræ. His teachings have, nevertheless, been of great value, since they have demonstrated the distensibility of the normal urethra, have clearly shown the full pathological effect of true stricture, however slight, and have rendered urethral surgery more exact.

A purely arbitrary standard has been established for convenience in classifying organic strictures in accordance with the degree of narrowing. This is expressed in the following definitions:

Strictures of large calibre are those through which a sound or bougie larger than No. 15 (F.) can be passed.

Strictures of small calibre are those through which instruments larger than No. 15 (F.) cannot be passed.

LOCATION OF STRICTURE

In the large majority of cases gonorrhœal stricture is situated in the bulbo-membranous portion of the urethra. The next most frequent seat is the first two and a half inches of the urethra, and the least frequent seat is the middle of the spongy urethra. Stricture of the prostatic region is extremely rare. The occurrence of stricture in these regions is due to the facts that they are exceptionally vascular, and, with the exception of the membranous urethra, are rich in glands and follicles, and that chronic urethritis is apt to become localized at these points.

The differences of opinion in regard to the localization of stricture are due to the different standpoints from which the subject is regarded. Those who

demand evidence of some organic change before admitting the existence of stricture, and who base their views on the examinations of specimens in museums, differ greatly in their conclusions from those who depend upon the findings of the urethrometer, and who believe in an almost unvarying relation between the calibre of the urethra and the size of the penis. In three hundred and twenty-one specimens examined by Sir Henry Thompson the stricture in two hundred and sixteen, or sixty-seven per cent., was found in the bulbomembranous region; in fifty-four, or seventeen per cent., within two and a half inches of the meatus;

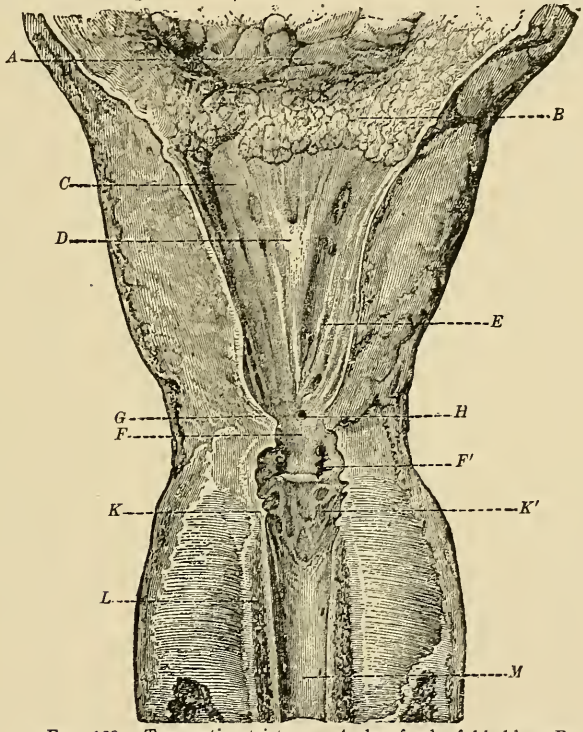


FIG. 129.—Traumatic stricture. *A*, bas-fond of bladder; *B*, ecchymosis of the mucous membrane of the vesical neck; *C*, prostatic urethra; *D*, verumontanum, much deformed; *E*, lacunæ; *F*, position of greatest narrowing; mucous membrane transformed to a thin layer of flat epithelial cells; *F*, small diverticula in the fibrous tissue; *G*, cicatricial tissue; *H*, small round cavity; *K*, spongy tissue completely destroyed; *K'*, mucous membrane in front of the stricture, thin and rugous; *L*, spongy body; *M*, anterior urethra. (Vollemier.)

and in fifty-one, or only sixteen per cent., in the intermediate spongy portion. Otis describes two hundred and fifty-eight strictures under his care as situated, one hundred and fifteen, or forty-four and one-half per cent., in the first inch and a quarter of the urethra; one hundred and twenty-nine, or fifty per cent., from one and a quarter to five and a quarter inches from the meatus; and only fourteen, or five and one-half per cent., from five and a half to seven and a quarter inches—*i.e.*, in the region of the bulbomembranous urethra. It can scarcely be doubted that many of these "strictures" were points of physiological narrowing.

Gonorrhœal strictures are usually multiple, two, three, four, or even more being present.

Traumatic strictures are nearly always single, and their situation varies with the cause. They occur in the mid-spongy portion of the urethra after rupture of a chordee; at the root of the penis when caused by "false movements" in coition; in the perineobulbar portions of the urethra when following contusions of the perineum; and in the membranous portion after pelvic fractures. They are most frequently found involving the bulbous urethra (Fig. 129).

Strictures following ulceration due to chancre, chancroid, or the lodgement of foreign bodies are usually found at or near the meatus.

CHANGES IN THE URETHRA

The urethra behind a stricture undergoes certain progressive changes. It at first becomes deeply congested, thinned, and dilated. As the stricture grows smaller, alterations in the mucous membrane become more and more marked. The increasing pressure causes a corresponding increase in the pouching or dilatation; decomposition of the retained urine sets up superficial inflammation, and erosion of the mucous surface occurs; ulceration follows, which, as it progresses, allows the escape of urine into the spongy tissue. Sooner or later this causes suppuration. The pus, whether in minute quantity or as the contents of a recognizable abscess, finds its way towards the skin, and after its discharge leaves urinary fistulæ. These fistulæ, when first formed, have soft, yielding walls, but these gradually become dense and indurated, undergoing the same pathological changes as did the original strictured region. Even after the formation of a large fistula progressive contraction still takes place at the posterior surface of the urethral stricture, since the fistulous opening cannot prevent the constant contact of urine with this portion of the narrowing. As a result, the urethral outlet is more and more tightly sealed, and all the urine is forced to pass by the new way.

Gradually, as the walls of the fistula become indurated, its lumen is narrowed by contraction, and the free passage of the urine is again obstructed. Under such circumstances it is extremely rare to observe any yielding in the stricture so that water can be voided per urethram. Ordinarily other abscesses develop in the way already described and other fistulæ are formed.

When fistulæ originate in the bulbar urethra it is from the region of one of the lateral angles of the canal that the fistulous tract passes. The sclerosed bulb is not traversed directly by this tract from above downward. It winds laterally round the half circumference of the bulb and opens through the skin. Sometimes the bulb is entirely dissected by two fistulous tracts placed symmetrically and laterally, uniting near a single suburethral pouch. These tracts are lined with stratified pavement epithelium continuous with the two surfaces; hence in closing them it is necessary to extirpate the whole tract. In exploring these tracts it must be borne in mind that they take a circuitous course, often entering the urethra by its lateral wall.

Wassermann and Halle have shown that the essential anatomicopathological characteristic of the lesions of gonorrhœal stricture is their multiplicity,

as opposed to the precise limitation and localization of traumatic strictures. In all cases of old gonorrhœal strictures the urethra exhibits pronounced lesions throughout a great part of its extent. These are most marked in the region of the bulb. The calibre of the urethra is lessened anterior to the stricture; behind it there is dilatation.

The epithelial lining of the urethra is constantly altered, thickening and partial desquamation representing the commonest lesions. These are found in all portions of the canal, even those least affected. There is constantly observed a tendency towards the transformation of the cylindrical epithelium to the stratified pavement form. Commonly there is a single basilar layer of cylindroid cells with the long axes perpendicular to the derm. The middle layer is made up of several rows of polygonal, usually hexagonal, cells; finally, there is a superficial layer continuous with the middle layer and made up of several rows of flat cells with the long diameter parallel to the surface. Sometimes the flattened superficial cell-layer rests directly on the basilar layer. All forms of transition are observed in the epithelial cells. The epithelium may be thinned and atrophic, or there may be proliferation, forming vegetating masses which fill the urethral calibre. Finger states that there is a distinct relation between the type of epithelial alteration and the pathological changes in the subjacent tissues. Distinctly dermoid and corneous epithelium (not observed in the membranous or prostatic urethra) is usually found in the regions where periurethral sclerosis is most pronounced.

The essential lesion of stricture is in the spongy body. As an ultimate result of inflammatory infiltration, fibrous tissue is gradually substituted for the elastic, extensible vascular tissue of the spongy urethra, forming a compact inextensible vascular mass showing a tendency towards retraction, atrophy, and obliteration. Usually the narrowing is caused by a fibrous ring, which may be regularly disposed or unequally deposited about the urethra. There is no system in its distribution. Sometimes it is the upper segment, sometimes the lower or lateral segments, that are most profoundly involved. At the strictured point one-half or two-thirds of the diameter of the spongy body is altered and obliterated.

The arteries of the spongy body in old cases constantly exhibit an endarteritis and a periarteritis, sometimes proceeding to complete obliteration of the vessels. Behind the stricture the superficial inflammatory lesions are almost constant, and it is here that embryonal vegetations form by predilection. The sclerosed tissue surrounding the urethra is not homogeneous, but contains all the elements of normal spongy tissue. It is the result of a species of interstitial sclerosis, which, though completely modifying the appearance and the properties of the normal tissue, does not cause its total disappearance.

In case of traumatic stricture the contrary is the case. The spongy body is entirely replaced *in loco* by an ordinary fibrous cicatrix.

The glandular and lacunar lesions of stricture are constant. Adenitis with proliferation and epithelial transformation, glandular dilatation, and simple periadenitis are nearly always found, especially in the least altered portions

of the strictured urethra. At the seat of stricture the glands have often disappeared or are scarcely recognizable.

The opening of the urethra at the seat of stricture is commonly near the roof of the canal, since the bulk of the fibrous tissue is usually placed in the urethral floor, thus encroaching upon the lumen of the canal from below upward. The opening may, however, be eccentric in any other direction.

The consistence of strictures varies with their age and with the amount of fibrous and elastic tissue they contain. Their *dilatability* varies inversely with their consistence, as does their elasticity.

Section of a stricture of the annular or tortuous variety shows a more or less imperfect ring of new inflammatory tissue, whose limits taper down gradually. This tissue is hard, yellowish white near the lumen and darker peripherally, where reddish islets are seen, the result of hemorrhagic infarcts, which form foci for new inflammatory changes. Oberländer has shown that the inflammatory process practically begins in the granular recesses. These are most abundant on the roof of the urethra, but the floor presents the greatest changes, from the fact that the gonorrhœal process is always more active there.

Complete obliteration of the urethra is extremely rare, and it is doubtful if it ever happens except in the traumatic forms of stricture following extensive laceration or complete cross-crushing of the canal. The obliteration in this case is usually at least half an inch wide, with fistulæ placed behind it.

SYMPTOMS OF STRICTURE

The phenomena produced by stricture vary with the degree and the character of the narrowing. They are most conveniently classified under the following headings: 1, subjective symptoms, those recognizable by the patient; 2, objective symptoms, those elicited by exploration.

Subjective Symptoms.—A. *Urethral History.* Well-planned questions should elicit the fact that there has been severe or recurrent urethritis of long duration; or traumatism to the urethra, perineum, or pelvis; or a urethral chancre or chancroid.

B. *Alterations in Micturition.*—1. Frequency. This arises at first from the change in relation between the expulsive efforts of the bladder and the resistance offered by the urethra; afterwards from extension of inflammation backward by continuity until the vesical neck is involved; from cystitis; and finally from atony of the bladder with the presence of residual urine. In these cases the frequency is worse by day, as in stone, not by night, as in prostatic disease.

2. Changes in the character of the stream, which may be double, flat, gimlet-shaped, or spray-like, and in tight strictures becomes much reduced in size, are often of slight significance, as the shape and size of the stream depend more upon the shape and size of the meatus than upon any condition posterior to it.

3. Diminution of expulsive power is a late symptom, and is developed only when vesical atony has succeeded the hypertrophy.

4. Dribbling after urination depends upon the retention of some drops of urine behind the stricture. These escape by gravity after the act of micturition is complete. It is usually an early symptom, caused by irregular action of the circular muscular fibres of the urethra.

The dribbling from the overflow of a distended bladder (incontinence of retention) is a very late symptom, and is associated with a high degree of atony of the bladder.

The incontinence of retention from stricture is at first always worse in the daytime, when the patient is up and about, while the incontinence of retention due to hypertrophy of the prostate is worse at night, when the patient is lying down.

5. Ardor urinæ is very variable, but is not apt to be marked unless there is a considerable degree of inflammation present.

6. Retention of urine may occur early and suddenly from an acute increase of the congestion of the mucous membrane in the strictured region, or it may be a late symptom dependent upon the direct obstruction occasioned by the slowly contracting stricture. In either case it is apt to be precipitated by fatigue or cold, or by alcoholic or sexual excess.

7. Vesical tenesmus is generally constant during the entire act of micturition; that of prostatic hypertrophy is most violent at the beginning and grows less as the water begins to flow; that of cystitis is most severe at the end of the act.

C. *Urethral Discharge.*—Opinions vary as to the constancy of gleet as a symptom, but it is probable that a large majority of strictures are accompanied by it. Most of those patients who exhibit no discharge show mucous and epithelial shreds and pus-cells in the urine.

D. *Interference with Coition.*—The physiological congestion of erection necessarily makes the lumen of a tight stricture still smaller, thus causing retention of semen behind the point of narrowing. This may be extremely painful because of the consequent distention of the urethra, often inflamed and hypersensitive. On subsidence of erection the stricture may become sufficiently patulous to allow the semen to drop slowly from the meatus.

Ejaculation is apt to be premature. The erection is often imperfect or subsides before the completion of the act.

E. *Constitutional Symptoms.*—These are late and depend upon vesical and renal changes, with accompanying alterations in the urine. They are, therefore, usually a combination of uræmic and septicæmic symptoms. There is a red glazed tongue, with anorexia, dyspepsia, constipation, etc. The dryness of the tongue extends to the walls of the pharynx, making swallowing painful; an irregular fever supervenes; the general strength fails, the face becomes pinched and yellow, the eyes sunken, and after rapid emaciation and profound prostration the patient dies comatose.

Of the subjective symptoms *frequent urination, dribbling,* and *gleet* are the most characteristic of stricture.

Objective Symptoms.—Guyon divides the urethra into six regions:

1. The navicular region, extending from the meatus to the corona.

2. The penile region, extending from the corona to the peno-scrotal juncture.

3. The scrotal region, extending from the anterior to the posterior scrotal wall.

4. The perineo-bulbar region, extending from the posterior scrotal wall to the anterior layer of the triangular ligament.

5. The membranous region.

6. The prostatic region.

It must be remembered that the superior urethral wall alone has anything like a fixed curve, while the inferior wall is a broken line. The inferior wall is extensible, soft, and depressible, and is subject to variations in form and length; hence the important point for the surgeon to remember during urethral instrumentation is that he should follow the curve of the superior wall, or by manipulations modify the direction of the urethra. The part most susceptible to modification or change in direction is that extending from the suspensory ligament to the entrance into the membranous division; anatomical knowledge and the "touch" must be depended upon to indicate the limit of modification which the urethra will bear without sustaining a lesion. The urethra has no lateral flexions or bends, but lies exactly in the median line. Nothing, however, is easier than to produce such deviation in the spongy urethra, especially in the bulbar portion.

The elasticity and extensibility of the urethra reside for the most part in the spongy portion, as is clearly demonstrated by erection, and this elasticity belongs in the greatest degree to the inferior wall, which permits of easy distention or elongation, while the superior wall yields with much less readiness. This difference increases with age and is especially marked in the senile urethra. It is therefore evident that since the extensibility of the inferior wall is brought into play by even a moderate force, the surgeon cannot count on its resistance. It glides before an instrument and cannot serve to guide it. It yields readily to a mechanical pressure testing its extensibility; it cannot be incised with any accuracy or precision; it ruptures when surprised by distention. It does not yield equally in all its parts, the perineo-bulbar portion of the canal being the most distensible part of the urethra.

The superior wall is more regular and constant in form and direction, presents the smoother and firmer surface, is less modified by mechanical pressure, offers the greater resistance to rupture and penetration, is less intimately connected with important structures, and is the less vascular of the two walls.

There are three relatively constricted points in the urethra, the internal and the external meatus, point of passage through the superficial layer of the triangular ligament, and three dilatations, the fossa navicularis, the bulbar cul-de-sac, and the prostatic expansion, all of which present numerous individual varieties. These dilatations are at the expense of the inferior wall of the canal (Fig. 130).

Diagnosis.—The best instruments for the diagnosis of stricture of the penile urethra are the so-called bougies à boule or the Otis urethrometer.

The size of the instrument (Fig. 131) selected for examination should

be determined approximately by noting the circumference of the flaccid penis at the middle of the spongy portion. The following is an average scale:

Circumference of penis,	3	inches;	calibre of urethra,			26–28	millimetres.
"	"	3¼	"	"	"	28–30	"
"	"	3½	"	"	"	30–32	"
"	"	3¾	"	"	"	32–34	"
"	"	4	"	"	"	34–36	"

The meatus should be cut if it is too small to permit the introduction of a bulbous bougie of the required size.

The penis, with the dorsum facing the abdominal wall, is held just behind the corona between the thumb and finger of the left hand, the foreskin having

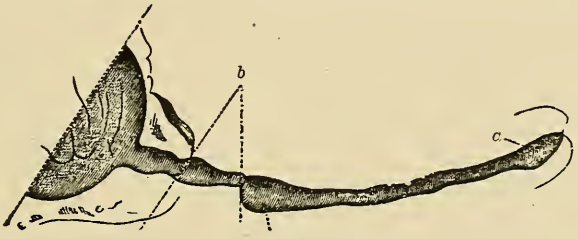


FIG. 130.—Cast of the urethra. *a*, navicular fossa; *b*, membranous urethra; *c*, expansion of the bulb. (Letzel.)

been retracted. The bougie, well oiled, is then passed gently to the triangular ligament. If it is arrested, the point of the shaft corresponding to the meatus is marked with the finger and the instrument is withdrawn. The distance from the meatus to the bulb of the bougie is then measured, and the region

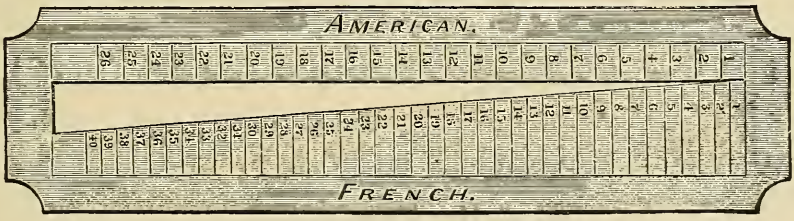


FIG. 131.—Gauge for urethral instruments.

of the contraction is carefully noted. If that instrument or a smaller size passes, it is withdrawn after a moment's delay, and if during its outward passage any contraction is found, it is probably due to stricture, although spasm may occasionally give rise to error in diagnosis.

The bougie is not passed into the posterior urethra, as the normal resistance of the posterior layer of the triangular ligament always noted on its withdrawal from this position renders its employment misleading. A sound should be used in the posterior part of the canal.

Solid steel sounds, if introduced gently, nearly always pass without difficulty the narrowing due to spasm. Pain is usually greater in spasm, but this is not sufficiently constant to be of diagnostic value.

When a stricture has been detected with a full-sized bougie and the location of its anterior face with reference to the meatus noted, bougies of progressively smaller calibre are used till one is found which will slip through the stricture. This instrument is then passed on in till it meets an obstruction or reaches the compressor muscle, after which it is slowly withdrawn, noting the position of any points by which the shoulder of the instrument is caught. If the Otis urethrometer is used in the exploration, withdrawal is not necessary till all the data have been obtained, as its size can be adjusted as desired, and a scale on the handle indicates the depth to which the dilating portion has been inserted. By noting the size of the instrument which will pass through a stricture, and the distances of its anterior and posterior faces from the meatus, an excellent idea can be obtained of the size, location, and extent of the strictured areas.

Sometimes, when no bougie à boule will pass, a steel sound several sizes larger will do so with ease. The information it conveys is not so accurate as that obtained by exploration with the acorn bougie, but is sufficiently so when the stricture is of small calibre.

In making a diagnosis between deep stricture and hypertrophy of the prostate the history and age of the patient are important factors. In prostatic hypertrophy the patient is apt to be over fifty years of age and gives a history of partial retention with nocturnal incontinence of urine; the urethra is lengthened, so that the shaft of a catheter must be entered to an unusual depth and the handle of a metal instrument must be more than ordinarily depressed before the beak reaches the bladder; the obstruction will be found at a distance of more than six and a half inches from the meatus, and a finger in the rectum will easily make out the enlarged prostate, or cystoscopic examination will disclose an hypertrophied median lobe.

The presence, location, and calibre of a stricture having been determined, its dilatability is ascertained by the use of the conical steel sound; but it is usually advisable to make this investigation at a subsequent visit.

RESULTS OF STRICTURE

Unrelieved obstruction of the urethral canal continued for a prolonged period produces, in addition to the local conditions already described, a series of changes in the urinary tract posterior to the lesion. Under long-continued and increasing pressure the urethra gradually enlarges, and the mucous membrane becomes thinned and pouched, projecting in places between the bands of muscular fibres, forming diverticula analogous to those seen in the bladder. Sometimes, instead of permitting the gradual escape of urine through minute openings, with the formation of small abscesses and fistulæ, the urethra gives way more largely at a point behind the stricture, and extravasation of urine follows.

Extravasation of Urine.—This serious complication of stricture is usually preceded by the following symptoms.

Symptoms.—After long continuance of the ordinary phenomena due to stricture, a tumor develops somewhat suddenly along the course of the urethra, accompanied by dysuria and frequent micturition or by complete retention.

If the extravasation is *gradual,* this tumor will fluctuate, open externally as an abscess, and form a urethral fistula.

If the extravasation is *sudden—i.e.,* if the wall of limiting inflammatory tissue thrown out at first is suddenly broken through by the efforts at micturition—while straining to evacuate the bladder a sense of something having given way is experienced, together with distinct relief of bladder tension, although no urine escapes externally, and a smarting or burning pain is felt about the seat of rupture.

The local symptoms are those produced by the retention of an irritant and often a poisonous fluid within the tissues. The parts swell and become œdematous, the color of the skin changes to a dusky red, purple, or dirty brown, emphysema occurs from the gases of decomposition, and spots of gangrene appear. When the urine is septic, sloughing may set in by the end of the first day.

The general symptoms are those of profound septicæmia, marked by great prostration, irregular temperature, a dry, glazed tongue, a running pulse, frequent shallow respirations, wandering delirium, and finally, if the condition is unrelieved, death in coma. These develop with greater intensity and rapidity if the bladder has been infected with putrefactive microbes and the urine is therefore fetid and purulent before extravasation takes place.

The localizing symptoms—those which indicate the point at which the urethra has given way—are based upon the course taken by the urine.

A. In case the pendulous urethra gives way, the result may be as follows:

1. When the urine is not septic and ammoniacal, and the extravasation is not very rapid, it may remain strictly limited, forming a blind internal fistula.

2. The urine may extravasate into the substance of the corpus spongiosum, passing forward in the course of the urethra, and finally involving the glans penis in the sloughing process. Brodie states that the appearance of a black spot on the glans penis after extravasation is a fatal sign, and Harrison concurs in this opinion.

3. The corpus spongiosum may be protected by inflammatory exudate, ulceration extending to, but not through, its strong fibrous envelope (Buck's fascia). In this case the urine may burrow forward, forming a long, indurated, fistulous tract, opening externally behind the glans, or on the dorsal surface near the root of the penis.

4. Ulceration may involve the common fascia of the penis at or near the point of rupture. In this case the loose cellular subcutaneous tissue of the penis becomes enormously œdematous, the swelling extending backward to the scrotum. This is the common course when rapid extravasation takes place from the pendulous urethra.

B. When extravasation occurs from any portion of the urethra included between the attachment of the scrotum and the anterior layer of the triangular ligament, usually the bulbar portion, the course of the extravasated urine is governed by the attachments of the deep layer of the superficial fascia—Colles's fascia. The urine will first occupy the space enclosed by this fascia in front and below and by the anterior layer of the triangular ligament behind, and, as it cannot reach the ischiorectal space on account of the attachment

of the fascia to the base of the ligament, and cannot reach the thighs on account of the insertion of the fascia into the ischiopubic line, it is directed into the scrotal tissues, and thence up between the pubic spine and the symphysis until it reaches the abdominal wall.

C. In case the membranous urethra gives way, the extravasated urine is confined to the region included between the layers of the triangular ligament, and gains access to other parts only after suppuration and sloughing have made for it an outlet. The symptoms following will then depend upon the portion of the aponeurotic wall which first gives way. If the anterior layer of the triangular ligament yields, the extravasation will take the course described as characteristic of extravasation from the bulbous urethra; if the posterior layer yields, the course of the urine will correspond with that taken when the prostatic urethra is ruptured.

D. If the opening is situated behind the posterior layer of the triangular ligament—in the prostatic urethra—the urine may either follow the course of the rectum and make its appearance in the anal perineum, or, as it is separated from the pelvis only by the thin pelvic fascia, it may make its way through the latter near the puboprostatic ligament, where the fascia is especially weak, and may spread rapidly through the subperitoneal connective tissue, sometimes forming abscesses in the hypogastric region.

The usual source of extravasation is from the bulbous and the membranous urethra, the urine infiltrating the perineum and scrotum and mounting upward to the belly-walls. When extravasation occurs from the membranous urethra the anterior layer of the triangular ligament nearly always gives way.

Prognosis.—The prognosis of extravasation of urine, except in those few cases where inflammatory reaction protects the surrounding tissues and where local abscesses and fistulæ are formed, is always grave. When the penile urethra is involved the skin usually ulcerates, thus allowing escape of urine before the extravasation has become widespread. Extravasation into the substance of the corpora cavernosa is fortunately rare.

In extravasation from the bulbous or membranous urethra there is little prospect of spontaneous relief being afforded by ulceration; hence prompt interference is necessary to prevent widespread sloughing and death from septic poisoning.

Extravasation from the prostatic urethra, and extravasation from the membranous urethra, with backward extension through the posterior layer of the triangular ligament, are the most dangerous forms of this complication of stricture, since the symptoms are not so characteristic that immediate diagnosis can be made, and since it is difficult to drain the infected tissues thoroughly when the infiltration is fairly started.

Treatment.—The treatment of extravasation of urine is sufficiently simple in theory. The two indications are prevention of further extravasation and thorough drainage.

Further extravasation is prevented by external perineal urethrotomy or perineal section. Usually an instrument can be passed, the breach in the urethral wall being upon the floor of this channel and not very large.

At the same time that the urethra is opened behind the stricture the latter should be thoroughly divided. The entire infiltrated area is drained by long multiple incisions; it is scarcely possible to overdo this part of the operation. Two cuts are required for the scrotum, two or three for the penis, and, if the case has lasted more than twenty-four hours, three or four for the abdominal walls. As much of the extravasated urine as possible should be squeezed out through these cuts by vigorous mechanical pressure, and the tissues should be washed with bichloride 1 to 4000. The cuts should be loosely packed with iodoform gauze and covered with hot antiseptic fomentations, changed every two hours (twenty layers of gauze wrung out in bichloride 1 to 4000 and covered with oiled silk).

When the prostatic urethra gives way, external perineal urethrotomy and drainage may not suffice. If the infiltration has been extensive, the parietal incision for suprapubic cystotomy will also be required, the prevesical space being irrigated and drained. By digital examination through the rectum, boggy or indurated areas can be detected about the base of the bladder and must be opened and drained through the perineum.

Bladder.—The bladder becomes affected as the stricture narrows. Occasionally, when the obstruction occurs suddenly, the walls are at once thinned and atrophied by overdistention. As a rule, however, a compensatory hypertrophy takes place first, the muscles become thick and rigid, the capacity of the viscus diminishes, and the muscular fibres stand out in bars or ridges, having between them lozenge-shaped spaces where the walls are greatly thinned. During the frequent and violent contractions of the viscus the mucous membrane is driven outward between these muscular partitions and the bladder finally becomes pouched at a number of places (see Plate V, c, Chapter V).

Usually there is also a severe cystitis developed by infection through the urethra, adding greatly to the severity of the symptoms. Exceptionally the sacculi rupture, causing collapse and death.

Ureters.—The ureters become dilated partly from the actual backward pressure of the column of urine incident to distention of the bladder, and partly from the frequent compression of their vesical ends during the oft-repeated acts of urination. Their oblique course through the walls of the bladder renders this compression very effective, and hydronephrosis is developed, causing mechanical obstruction to the secretion of urine.

Kidneys.—Sooner or later microbic infection takes place and the renal alterations due to suppurative inflammation follow. A pyelonephritis first develops, and then foci of suppuration are formed at different points through the cortex and beneath the capsule, until finally the kidney is converted into a large abscess-cavity, or into a series of pus-containing sacs, held together by the capsule and inflammatory lymph, and showing no trace of the secreting structure. This condition is called surgical kidney.

Among the possible results of stricture may be mentioned vesical calculus, impotence, sterility, rectovesical fistula, and very rarely spinal sclerosis or some of the forms of cerebral disease.

PROGNOSIS OF STRICTURE

The prognosis as to life depends, of course, on the stage which has been reached and upon the estimate which may be formed of the secondary organic changes that have already taken place. Relief of the obstruction, drainage and antisepsis of the bladder, milk diet, renal antisepsis, etc., often work astonishing changes in apparently desperate cases.

Fenwick has forcibly called attention to the fact that in the practical treatment of stricture we too often concern ourselves merely with the mechanical removal of the obstruction, and do not pause to ascertain to what extent the secreting structure of the kidney has been weakened or rendered susceptible to the invasion of inflammation from continuous surfaces.

Fenwick emphasizes the fact that in the obstruction offered to the overflow of urine by unrelieved stricture three muscular systems—the vesical, the ureteric, and the cardiac—become successively affected with hypertrophy.

TECHNIQUE OF URETHRAL INSTRUMENTATION

Two things are of the utmost importance in all urethral manipulations, gentleness and cleanliness; of the two gentleness is probably the more important. Avoidance of traumatism not only saves the patient pain, but safeguards him by not opening avenues for infection.

There are three ways in which a patient may become infected during urethral manipulations—from bacteria on the instruments introduced into the urethra, from bacteria already present on his genitalia, and from bacteria on the hands of the surgeon.

The first source of danger is easily eliminated by the application of adequate methods of sterilization (see Chapter III).

The second is a much more difficult problem, as it is utterly impossible to completely free the urethra and the surrounding skin of all germs. Yet practically the following procedures yield satisfactory results. So far as the integument is concerned, for such procedures as catheterization and the passage of sounds it is sufficient to wipe off the glans with cotton moistened with alcohol, soap-suds, or bichloride solution; for posterior urethroscopy, cystoscopy, and cutting operations the penis, scrotum, perineum, and the inner aspect of the thighs should be scrubbed with soap and water and bichloride solution. For the cleansing of the interior of the urethra we have but one reliable antiseptic, silver nitrate in strengths of 1:5000 or greater, and this solution is so irritating to many patients that its use is not justifiable as a routine procedure. We therefore rely largely on mechanical cleansing with bland solutions. Of these none is better than the patient's urine when this is sterile. When the urine is infected or the patient is unable to void, the anterior urethra should be thoroughly syringed with such solutions as normal saline, boric acid, potassium permanganate (1 to 4000), protargol (1 to 2000), etc.

For operative procedures, catheterization of the ureters, etc., the surgeon's hands should be scrubbed and sterilized in the ordinary manner, but for the simple office manipulations it is far better and safer for him to simply wash his hands with soap and water, and, considering them nonsterile, to

avoid touching any portion of an instrument destined to be placed inside the urethra. Even catheterization with a soft-rubber instrument can be performed without touching the intra-urethral portion of the instrument with the fingers by manipulating it with a pair of forceps (see Fig. 41).

As a preventive of epididymitis atropine has been used with asserted good results before the passage of urethral instruments. It is given with the idea of preventing spasm and reverse peristalsis of the vasa following traumatism to the orifices of the ejaculatory ducts.

PASSAGE OF METAL INSTRUMENTS

Urethral Curve.—The fixed curve of the urethra—*i.e.*, the curve assumed by the majority of adult urethras in a condition of rest—is measured from

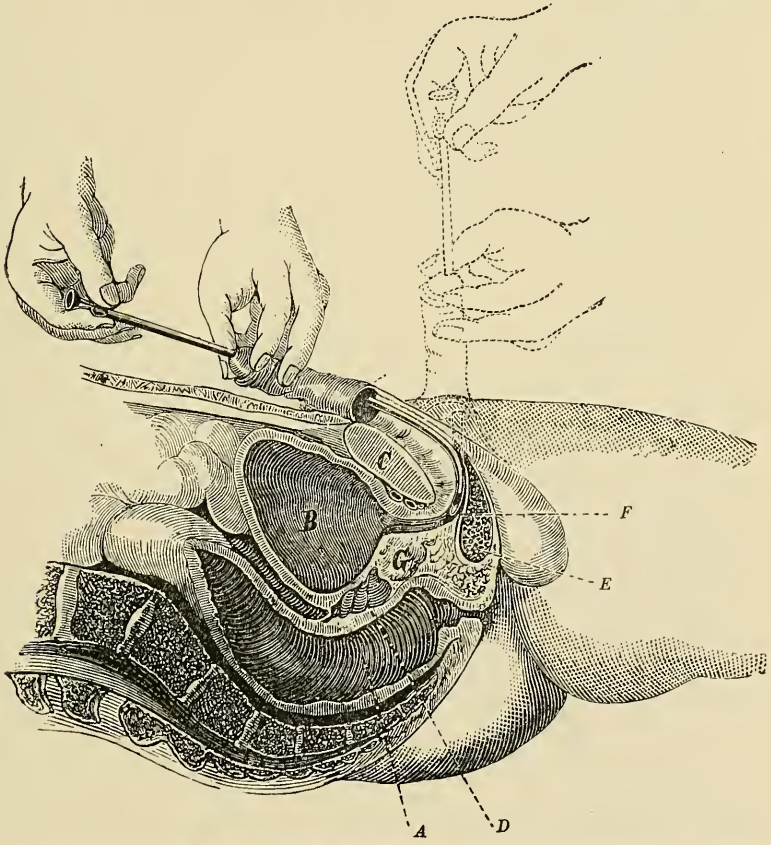


FIG. 132.—Tip of catheter just entering the fixed curve of the urethra. (Antal.) *A*, rectum; *B*, bladder; *C*, symphysis pubis; *D*, seminal vesicle; *E*, bulb; *F*, tip of instrument entering the fixed curve of the urethra; *G*, prostate.

just in front of the triangular ligament to the neck of the bladder (Fig. 132). It is theoretically considered as that part of a circle of three and one-quarter inches diameter which is subtended by a cord two and three-quarters inches

long (Fig. 133). Practically this curve varies greatly from this standard. Indeed, it is not a continuous curve. Depressing the urethra by means of a finger placed on either side of the root of the penis somewhat straightens

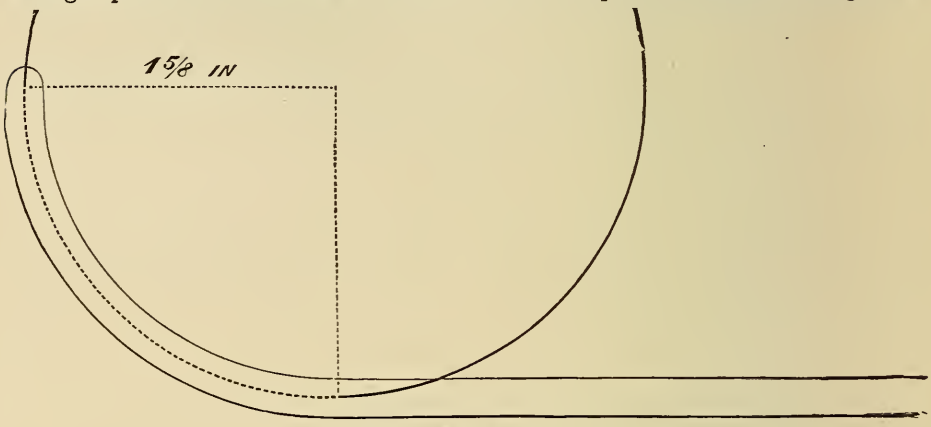


FIG. 133.—Fixed urethral curve.

the curve. It is always lengthened by hypertrophy of the prostate and may be temporarily obliterated by passing a straight instrument into the bladder (Fig. 134).

Passing the Sound.—For the passage of a properly made steel sound or

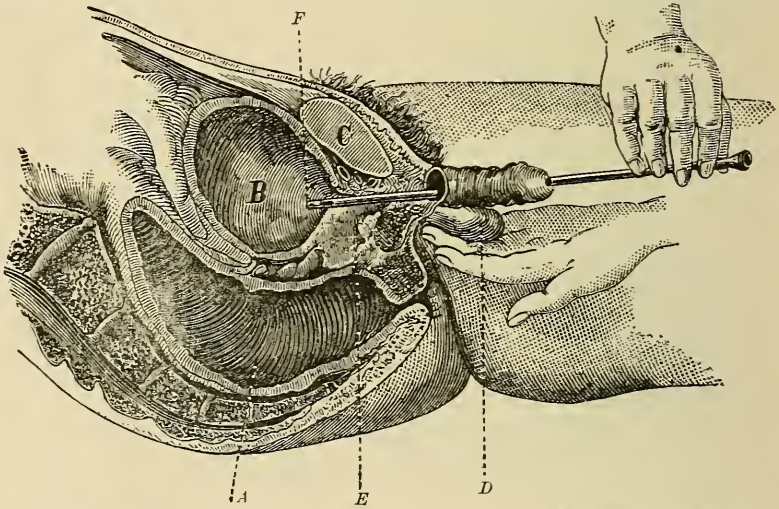


FIG. 134.—Fixed curve of the urethra obliterated by the passage of a straight instrument. (Antal.) *A*, rectum; *B*, bladder; *C*, symphysis pubis; *D*, scrotum; *E*, prostate; *F*, tip of catheter in bladder.

silver catheter, the curve of which corresponds with that given above, the patient should be placed in the recumbent position, with the head and shoulders slightly elevated, the knees a little separated, and the muscles relaxed. The surgeon, if right-handed, stands at the left side of the patient. The sound

or catheter, having been previously sterilized, warmed, and lubricated, is taken in the right hand, and, the foreskin having been retracted, the penis is held between the middle and ring fingers of the left hand. The organ is

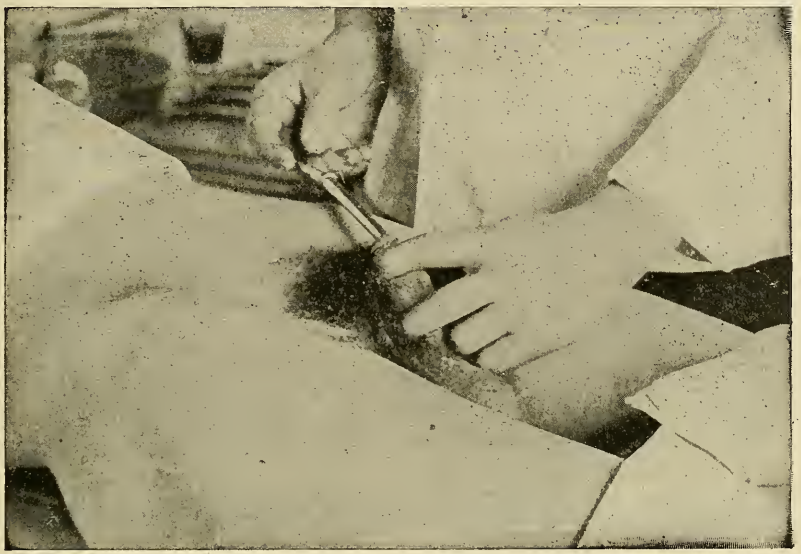


FIG. 135.—Passing the sound. The shaft is kept parallel to Poupart's ligament till the tip has reached the bulb.

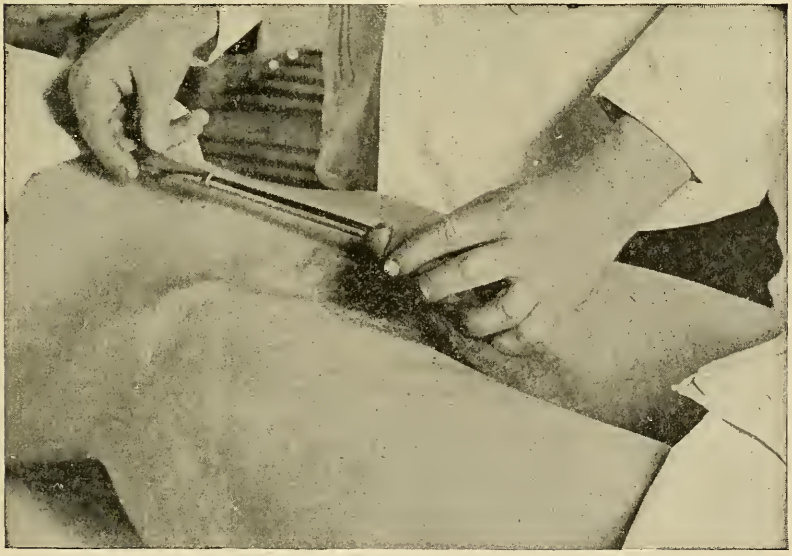


FIG. 136.—Passing the sound. Handle carried to the midline.

gently put on the stretch, care being taken to keep the dorsum towards the abdominal wall, so as to avoid making twists in the urethra, the lips of the meatus are separated by the thumb and finger of the left hand, and the tip of the instrument is passed into the urethra. At this time the shaft of the

sound or catheter should be parallel to the line of the groin (Fig. 135). This is important chiefly in persons with large, protuberant bellies, in whom, if this rule is not followed, the tip of the instrument will be made to catch against the anterior layer of the triangular ligament, owing to the elevation of the handle necessitated by the prominent abdomen. In any event, the handle of the instrument must be kept low until the tip is about to enter the membranous urethra. Having engaged the point of the sound, the penis is now drawn up with the left hand, while the instrument is gradually pushed onward, until three or four inches of the shaft have disappeared, when the handle is swept inward to the median line, the shaft being kept parallel to the anterior plane of the body and nearly touching the abdomen (Fig. 136). The handle is then raised from the abdominal wall and swept gently over in the median line, while the left hand is shifted to the perineum (Fig. 137), where it guides

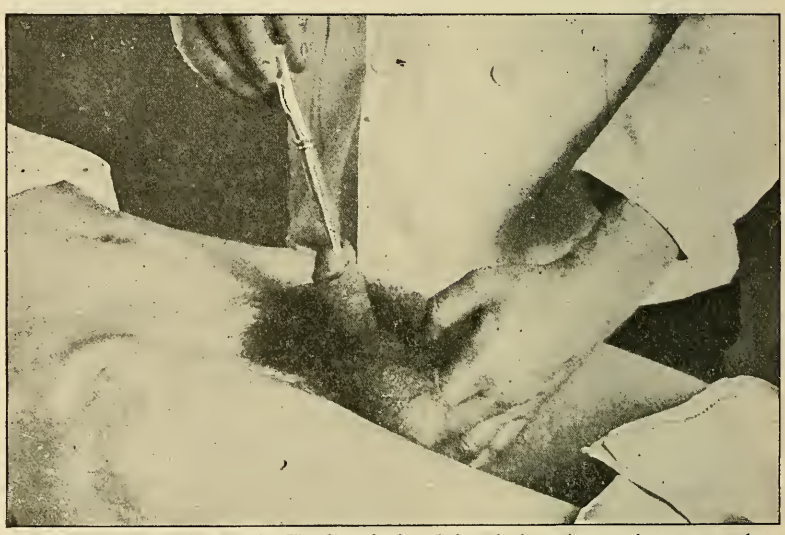


Fig. 137.—Passing the sound. Handle raised to bring tip into the membranous urethra.

the tip of the sound into the membranous urethra. After the shaft has passed the perpendicular, the handle is taken in the left hand, and the index and two fingers of the right hand are placed one on either side of the root of the penis, making downward pressure, while the left hand depresses the handle between the legs, carrying the point of the instrument through the membranous and the prostatic urethra into the bladder (Fig. 138). The entrance into this organ is recognized by the free motion of the tip of the sound when the handle is rotated, and by the fact that the instrument remains exactly in the median line and points away from the pubes when the hold upon it is relaxed (Fig. 139). The whole manœuvre must be effected with gentleness; no force is necessary.

If there is a spasm of the circular muscular fibres of the urethra at any point, or of the compressor urethræ at the bulbomembranous juncture, gentle steady pressure for a minute or two usually will be followed by relaxation.

If the handle is lifted too soon from its proximity to the abdominal wall, the tip of the instrument catches in the subpubic ligament above the urethral orifice; or if the handle is not raised soon enough, or if the fingers on the

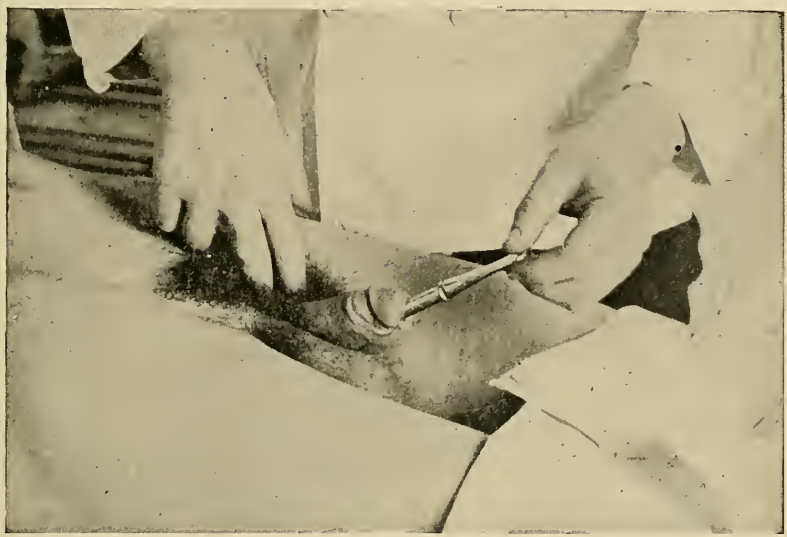


FIG. 138.—Passing the sound. Handle carried toward patient's feet, while pressure is made at the root of the penis to assist in obliterating the fixed curve of the urethra.

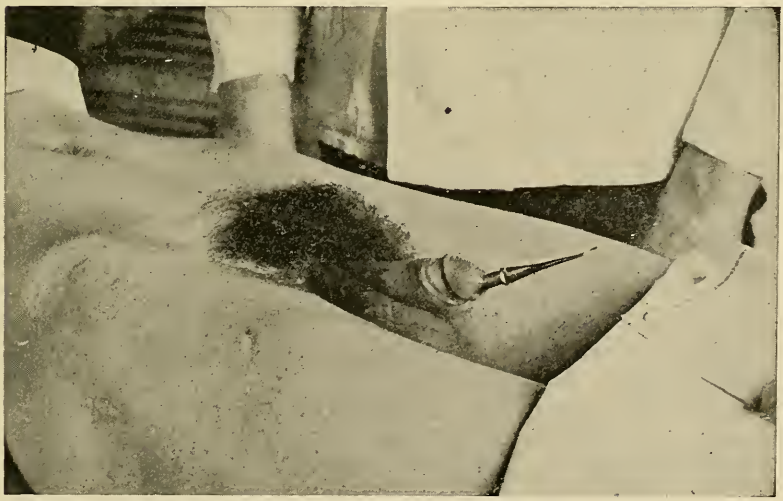


FIG. 139.—Position of sound when tip has entered the bladder.

perineum do not give the curve of the instrument the gentle upward pressure that it needs, the tip buries itself in the loose and movable floor of the bulbous urethra below the orifice of the membranous portion of the canal (Fig. 130). In either case the curve of the sound protrudes unnaturally in the perineum.

The withdrawal of the instrument for an inch or two and its reintroduction, raising or lowering the tip as may be required, will suffice to overcome the obstacle.

If the instrument is used with ordinary care and gentleness and has been properly sterilized, and if it is immediately followed by a total antiseptic irrigation (protargol 1 to 2000 to 1 to 200), the production of prostatitis, epididymitis, or urethral fever will follow with extreme rarity. In a majority of cases these complications are due to the use of force in the introduction of the bougie, when the instrument practically becomes a divulsor, or to a slovenly disregard of asepsis, either the instruments not having been sterilized or the urethra not having received irrigation before manipulation.

URETHRAL FEVER

Urethral fever (urinary fever, catheter fever) follows trauma and is due to absorption of bacteria or toxins through a hyperæmic or abraded mucous surface.

Since the passage of an instrument into the urethra has been shown to produce a sudden, sometimes very pronounced, fall of blood-pressure, it is not difficult to account for the syncope so frequently observed as a result of even the most gentle introduction of a sound. As a direct or remote result of this primary reflex influence on the circulation it is conceivable that the secretory function of diseased kidneys may be abolished, and that death may result from anuria. Such cases—*i.e.*, those characterized by syncope, collapse, or anuria, presenting all the symptoms of shock and exceptionally terminating fatally in a very few hours—are not properly classed under urethral fever, and should receive the immediate stimulating treatment appropriate to syncope or shock, and afterwards that called for in acute suppression.

The reflex element, aside from primary syncope, plays but a minor *rôle* in the development of the phenomena known as urethral fever. Albarran reports a case of internal urethrotomy in which the bacterium coli communis was found in the blood of the patient, who died twelve hours after operation, this same microörganism being discovered in the urethral pus. From this and from many similar cases it would seem clear that even though the classical symptoms of septic absorption are absent—*i.e.*, chill, fever, and sweat —and though the case progresses to a fatal issue in a few hours, this rapid and irregular course does not necessarily imply a reflex nonseptic inhibition of the renal function.

Retention of urine, with the consequent effects on the bladder walls and the kidneys (*i.e.*, chronic cystitis, pyelitis, and nephritis), acts as a strong predisposing factor in the development of urinary fever. As an exciting cause, contact of infected urine or of purulent discharges with fissure or abrasion of the mucous membrane of the urethra is sufficient. Urethral fever by no means follows as a rule in consequence of such contact. It is well known that forcible, clumsy, unsuccessful catheterization, attended by profuse bleeding and rupture of the urethra, may be followed by no constitutional symptoms, while the most skilful and gentle introduction of an instrument may cause a malignant form of urinary fever.

Lesions situated behind stricture and seats of obstruction, and particularly lesions of the deep urethra, are more liable to be followed by urinary fever than are wounds so placed that the septic fluids are not driven into them.

It has been noted frequently that in cases where urinary fever occurred each time a stricture was sounded, instruments could be passed with impunity on complete cure of the narrowing. In some cases no fever develops till after the urine has come in contact with the raw surface; thus it is not uncommon to have a posturethrotomy urinary fever delayed till from the third to the fifth day, when the permanent catheter is removed and the urine flows under pressure over the raw surfaces. After perineal urethrotomy and cystotomy, urinary fever is extremely rare.

The constitutional symptoms incident to rapid extravasation of urine are those characteristic of diffuse cellulitis, and are not properly classed with urinary fever.

Symptoms.—The particular form in which urinary fever may manifest itself is quite independent of the severity of the exciting lesion, since in at least one reported case, in which death occurred a few hours after the passage of a catheter, no breach was found in the continuity of the mucous membrane. The character of the fever is dependent on the virulence of the germs and on the tissue resistance of the individual.

Acute urinary fever may take either of the two following forms: (1) single paroxysm, (2) recurrent paroxysms.

Acute Urinary Fever.—*Single Paroxysm.*—This is characterized by chill, fever, and sweat. The chill may come on a few minutes after catheterization; usually it follows the first act of micturition subsequent to urethral interference. The chill is pronounced, the fever high, 103° to 105° F., the sweat copious (Fig. 140).

At the height of the paroxysm there may be pain in the head and back, delirium, unconsciousness, dyspnœa, nausea, and vomiting. Usually the pulse is full and strong, the mind is clear, and the patient feels comparatively well.

Exceptionally the chill is unduly severe and prolonged, lasting possibly for several hours; the patient becomes collapsed, vomits, purges, ceases to secrete urine, and dies in a few hours, or in one or two days, of shock, of uræmia, or of virulent septic poisoning.

The form with recurrent paroxysms is characterized by irregular and apparently causeless elevations in temperature, preceded by rigors or chills, which are not so well marked as in the first attack, and followed by sweats. The temperature in the interim does not reach normal, the heart action continues unduly rapid. These paroxysms may occur several times a day, or the intervals may be of one to several days' duration. Oppression in breathing and congestion of the lungs are often noticed. In favorable cases these attacks cease in a few days or a week and the patient shortly regains strength, though not so rapidly as after the single paroxysm. When there are foci of suppuration, as in cases of pyelonephritis, prostatic abscess, or limited urinary extravasation, septicæmia or pyæmia may develop, with characteristic

symptoms, and, if the infecting focus is not found and drained, usually with a fatal termination.

Chronic Urinary Fever.—This may directly follow either of the preceding forms, or may develop insidiously, at times without elevation of temperature. Long-standing retention, and the consequent changes in the bladder and kidneys, are the common predisposing factors. The exciting factor is infection incident to catheterization, and the foci of infection are usually in the kidneys.

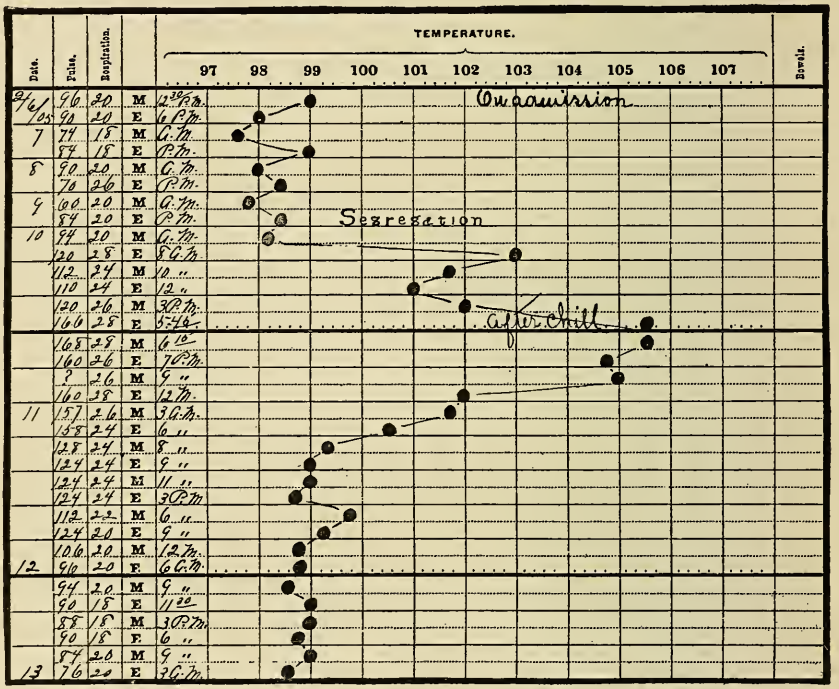


FIG. 140.—Chart of patient with acute single paroxysmal urethral fever. Infection incident to segregation. A moderate fever six hours after instrumentation was complicated by a severe chill, lasting one-half hour, accompanied by fever of 105⅗ degrees. The pulse, after the chill, was for a time imperceptible and remained weak and rapid for twelve hours.

Symptoms.—The symptoms of this form of urinary fever are septic or uræmic. Hectic—*i.e.*, irregular paroxysms of chills, fever, and sweat, with progressive loss of strength—may be combined with dry brown tongue, vomiting, diarrhœa, headache, and stupor. This condition may last for weeks.

PROGNOSIS.—Urethral fever, when it appears as a single paroxysm, none of the stages of which are markedly severe or prolonged, is not especially serious. A heavy, prolonged chill, especially if it is associated with a rapid pulse-rate out of proportion to the temperature, and with suppression of urine, always suggests a malignant and at times a rapidly fatal form of infection.

In recurrent paroxysms, if the kidneys are healthy and the patient is young, the prognosis is fairly good.

In chronic urinary fever the prognosis must be guarded. Old prostatics who have suffered long before being relieved usually die when this form of urinary fever develops; indeed, it is commonly a sign of septic infection of the kidneys. In younger men with retention from stricture the prognosis is somewhat more favorable.

For the prevention of the development of urethral fever rigid asepsis and the greatest gentleness should characterize all operations on the urethra and bladder, especially in the presence of retention of urine. When the operation is planned some time in advance, forty to sixty grains of hexamethylenamine should be given during the preceding twenty-four hours, and if the urine be not strongly acid ninety grains of the acid phosphate of sodium should also be administered. The urethra should be flushed out with a sterile solution (silver nitrate, 1 to 5000; potassium permanganate, 1 to 4000; boric acid, 2 to 4 per cent.; normal saline solution) before any instrument is introduced, and at the close of the operation or examination, both it and the bladder should receive a thorough, gentle lavage.

Treatment.—Before operating on the urethra a preliminary bacteriological examination of the urine is advisable. If virulent colonies of the colon group are found, it is well to postpone operation till these have disappeared as a result of internal vaccine and local cleansing treatment, or if surgical interference is urgently demanded this should be followed by perineal drainage.

Acute urinary fever, characterized by a single paroxysm or by recurring paroxysms, provided the urine is abundant and normal and the circulation is not materially disturbed, requires only rest in bed, the administration of urinary antiseptics, a bland liquid diet, preferably milk, and a mild saline, Hunyádi or magnesium sulphate, in sufficient doses to cause three loose passages a day.

When the constitutional symptoms are well marked, the pulse becoming progressively more rapid and feeble, stimulants and tonics are indicated, much the same treatment being pursued as for septicæmia. Should the urine become loaded with albumen or contain blood, or should the kidneys cease to secrete, dry cups over the loins, a half-dozen to each side, full doses of tincture of digitalis, a teaspoonful thrice daily (Otis), and on the supervention of uræmic symptoms the hot vapor bath, repeated according to the indications, are the measures which promise best results.

When in spite of careful local and general treatment symptoms of septic absorption are steadily progressive, perineal drainage should be established, supplemented by copious urethral and vesical irrigations. This operation is indicated only when the urethra, prostate, or bladder exhibits possible foci of infection, or when a pyelonephritis, the usual cause of the toxic symptoms, is exaggerated by an inadequately drained bladder. In the absence of such conditions it is not only futile but is often promptly fatal.

TREATMENT OF ORGANIC STRICTURE

The treatment of stricture in the male may be summarized as follows:

1. Narrowings at or near the meatus, if treated at all, are always cut (meatotomy).

2. Strictures of large calibre (greater than 15 F.) are treated by gradual dilatation. Cutting is almost never required when such a stricture is in the deep urethra; it is sometimes necessary when the stricture is anterior to the bulbomembranous juncture.

3. Strictures of small calibre are treated by gradual dilatation if possible; when in the deep urethra they occasionally require external urethrotomy; when anterior to the bulbomembranous juncture they usually require internal urethrotomy.

4. Impermeable strictures are treated by perineal section; at times excision and mucous membrane grafting are indicated.

5. Soft, recent, uncomplicated strictures are always dilated.

6. Fibrous (traumatic), nodular, and irritable strictures and those complicated by fistula are always cut.

GRADUAL DILATATION

The instruments for the gradual dilatation of stricture consist of a set of whalebone filiform bougies; a set of tunnelled catheters, ranging from No. 8 or 10 to No. 18 French (Fig. 141); a set of Van Buren's conical steel sounds, running from No. 12 to No. 36 French; and flexible bougies—acorn, conical, and bulbous or olive-tipped.

Though the conical steel sounds are commonly used in the curative treatment of strictures of large calibre, the woven bougies with lead core bulbous tip and *flexible neck behind this tip* are at times invaluable. This is particularly the case when the opening of the stricture is eccentric, and for small-calibre strictures. The flexible instrument under such circumstances allows of easy penetration with the least possible amount of traumatism, and can often be passed without difficulty when the introduction of steel sounds is impossible.

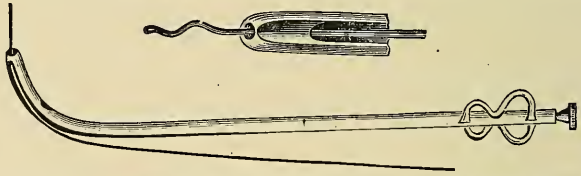


FIG. 141.—Tunnelled catheter. Enlargement of tip showing position of tunnel.

The method of treating stricture by gradual dilatation consists in the passage of instruments of increasing gauge at intervals of from three to five days, till the stricture readily admits an instrument corresponding in size to the normal calibre of the urethra.

Each sounding is followed by a slight and transitory hyperæmia of the region about the stricture, and during this time, particularly in recent cases, there is an appreciable softening and absorption of the stricture tissue. This period lasts from three to four days, and not until it subsides is the passage of an instrument to be repeated.

Ordinarily an advance of one or two numbers of the French scale may be made each time, but occasionally the same instrument must be introduced at several sittings before it can be exchanged for a larger one. This is deter-

mined by the degree of resistance experienced during its introduction, the pain which it excites at the time and afterwards, and the presence or absence of bleeding. Personal experience soon becomes the best guide as to the degree to which dilatation may be carried at any one sitting, though the feelings of the patient should always be consulted. When the full size has been reached (*vide* table, p. 257) the symptoms will usually disappear, and after this it is only necessary to carry on the dilatation at increasingly longer intervals to maintain the calibre of the urethra.

A certain proportion of cases under this plan of treatment will get entirely well, so that years afterwards no trace of stricture can be discovered. Others, if the intervals between the introduction of the sound are too long, will have a slight recontraction, evidenced possibly by a recurrent gleet, and the treatment will have to be repeated.

The introduction of a sound into any stricture which it fills without causing laceration is accompanied by certain phenomena. There is felt, at the end of a minute or two, a difficulty in withdrawing the instrument. Soon the spasm disappears, and movement of the sound becomes easy again. Some hours later a muco-purulent discharge is established in the canal, and in a few days the stricture allows the passage of a larger sound. The permanent enlargement obtained is principally due to absorption incident to the congestion excited in the stricture by the presence of the foreign body, and not to the mechanical dilatation and pressure of the sound. Therefore, when it is desired to make this inflammation a little more severe, it is well to leave the sound *in situ* for five or ten minutes. The point may be withdrawn a little during this time, to avoid irritation of the bladder. The effect of sounds of gradually increasing size is to stimulate the work of absorption and to cause the contractile elements to atrophy and the urethra to resume approximately its normal character.

These remarks apply to all strictures except those complicated with abscesses, fistulæ, urinary extravasation, etc., or those in which there is marked resiliency, or where instrumentation is followed by rigors and urethral fever.

All surgeons are agreed that *uncomplicated strictures of large calibre should be treated by gradual dilatation when they are at or behind the bulbomembranous juncture.* Moreover, there is a general belief that uncomplicated large-calibre strictures of the pendulous urethra should be given a fair trial at this method before urethrotomy is advised.

Strictures of Small Calibre.—In beginning the treatment of a stricture of small calibre it is best to pass through it a steel sound, provided its introduction requires no force. It is not safe to use a sound smaller than No. 8 or No. 10 of the French scale, as even in the most skilful and experienced hands there is an unavoidable danger of lacerating the inflamed and degenerated mucous membrane around the strictured region. It is in the exploration of deep stricture of small calibre that "false passages" are made, and usually with small metallic instruments, either sounds or catheters. The mucous membrane in front of a tight stricture is generally inflamed and softened, and thus offers but little resistance to the point of an instrument.

When a *false passage* is made, the sensation conveyed to the hand differs

markedly from that attending a successful catheterization. The point of the instrument is not in the median line, and is held with unusual firmness. There is bleeding, and the finger in the rectum detects the deflection of the instrument, and the absence of the normal thickness of urethral and prostatic tissue beneath its curve. The immediate treatment after making a false passage consists in rest in bed, urethral and urinary antisepsis, continuous catheterization for some days (if a catheter can be inserted), and the avoidance of further instrumentation for some weeks. Should perineal abscess or urinary infiltration follow, prompt incision is indicated.

If a sound is passed through a stricture of small calibre, it should remain five or ten minutes and then be withdrawn. Thereafter it is best to wait three or four days before passing another instrument, in the meantime administering five-grain doses of salol or urotropine four to six times daily, with a full dose of quinine morning and evening. At the next sitting it is well to recommence with the same instrument, after which one, two, or three larger sizes may be used in succession, provided their introduction is easy and not accompanied by pain or bleeding. Hemorrhage and pain are indications for lengthening the intervals between treatments and for more slowly increasing the size of the instruments used.

Once fairly established, however, the treatment by dilatation is carried on until the full normal calibre is reached; usually this requires from three to twelve weeks.

If the stricture is not resilient or irritable, and is not traumatic in its origin, it will then be found that all symptoms have disappeared, unless perhaps the gleet persists for a time. This, too, will often have subsided; but, in view of the extensive and serious urethral lesions always associated with long-standing stricture, it is apparent that gleet may persist in spite of full dilatation, even though it is reinforced by most careful local and general treatment.

When the stricture is a recent one, complete absorption of all fibrous tissue may take place, but in any event the occasional introduction of a steel sound will always keep the case under control.

Strictures of Small Calibre Permeable Only to Filiform Bougies.—In certain cases no steel sound or ordinary soft instrument can be made to pass the stricture, but a persevering trial with whalebone filiform bougies will result in the passage of one into the bladder. This trial should be made persistently and patiently, and in the absence of retention of urine may be frequently repeated. After anæsthetizing the urethra and relieving local congestion by an instillation of adrenalin chloride, 1 to 2000 in a four per cent. eucaine solution, the urethra is slightly overdistended anterior to the stricture with sterile oil injected by means of a piston syringe. A filiform is passed down to the stricture, and if, after patient, gentle effort, it refuses to enter, it is withdrawn, and is given an angle of forty-five degrees by bending it across the thumb-nail at about a quarter of an inch from the end. As the orifice of a tight stricture is frequently not in the middle of the obstructed urethra, but at some point around its circumference, this manœuvre will often enable the surgeon to enter it when with a perfectly straight instrument he cannot do so. If this does not succeed, several filiforms are passed by the

side of the first one, to impinge on the irregular surface of the stricture at a number of points; then by attempting to pass first one and then another of these (Fig. 142) the filiform bearing the right relation to the orifice will usually be found and can be introduced into the bladder. If this fails and one filiform can merely be engaged in the stricture, it is often best, in the absence of retention, to tie it in place (Fig. 143) and allow it to remain for twenty-four hours. In the great majority of cases at the end of this time it can be passed through the stricture. After the first instrument is introduced, four courses are open to the surgeon.

A. *Continuous Dilatation.*—1. The filiform may remain in place, with the certainty that in one or two days others may be slipped alongside of it, and

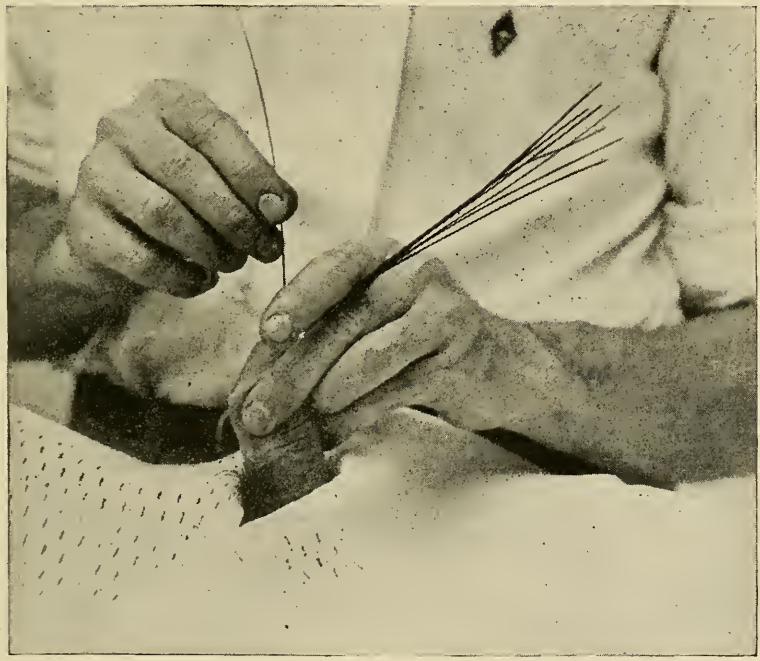


FIG. 142.—Method of passing a filiform bougie through a small stricture.

may be used as guides for the introduction first of a tunnelled catheter and later of an ordinary soft or steel instrument.

2. An immediate attempt may be made to pass into the bladder a tunnelled catheter (Fig. 144), and if successful leaving it to act for twenty-four hours by continuous dilatation; later, gradual dilatation may be employed.

B. *Urethrotomy.*—3. A tunnelled and grooved staff may be passed over the filiform, and external urethrotomy may be performed.

4. The filiform may be used as a guide for a Maisonneuve urethrotome, and internal urethrotomy may be performed.

If the stricture which is being dealt with is not of traumatic origin, and is not especially resilient or irritable, the first method will lead to the adoption

of gradual dilatation with the greatest degree of comfort and absence of anxiety to both the patient and the surgeon. Even if there has been moderate retention, it is certain that the urine will pass with increasing freedom by the side

FIG. 143.—Filiform whalebone bougie tied in the urethra after entering the stricture.

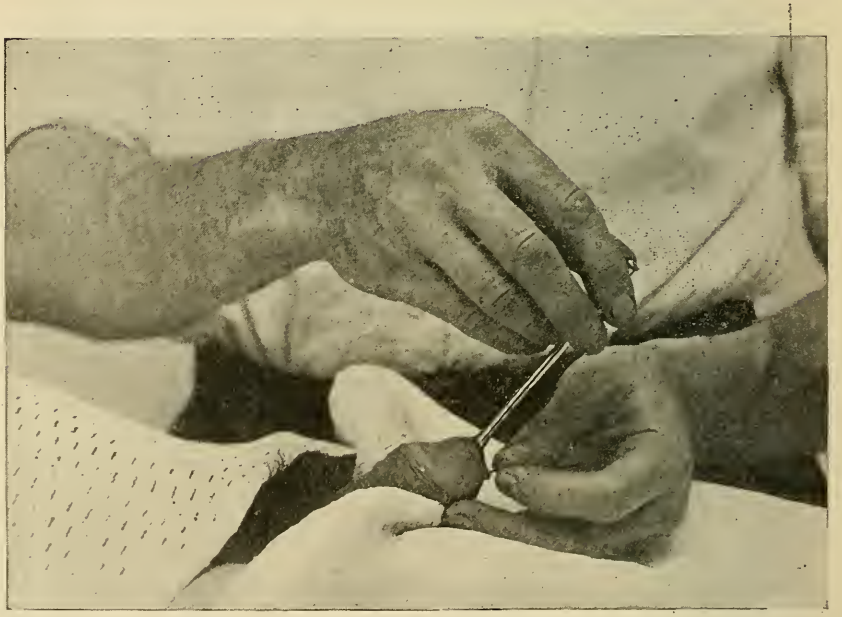


FIG. 144.—Method of passing Gouley's tunneled catheter.

of the filiform, and that the danger of the case is over so far as retention is concerned.

If retention has been complete for many hours and it is necessary to give immediate relief to the overstretched bladder-walls, it is best to adopt the second method—that is, pass a catheter at once. Failing in this, the third method, or external perineal urethrotomy, should be employed. In all deep strictures when instrumentation occasions rigors the external cutting operation is indicated.

Internal urethrotomy is practised in cases of tight, bulbomembranous stricture complicated by retention only when the patient refuses to have the external operation performed. In the best hands it is attended with a distinctly larger mortality than any of the other methods mentioned, and there is no evidence that it is followed by any larger percentage of permanent cures.

CONTINUOUS DILATATION

As intimated above, continuous dilatation is particularly applicable to those cases in which nothing larger than a filiform bougie can be passed through a stricture. It is also applicable to those strictures which do not respond well to gradual dilatation, particularly in the presence of strong contra-indications to urethrotomy.

Instruments are retained in the urethra by tying them in some manner to the exterior of the penis. Filiform bougies can sometimes be retained by passing a piece of heavy silk around the penis just back of the glans and tying its ends about the bougie (see Fig. 143). This forms a light, comfortable dressing, but one which is not so secure as that usually employed for the retention of catheters (see Figs. 43 and 44), consisting of straps of adhesive plaster applied to the sides of the penis, having silk or linen threads attached to their ends. When a woven catheter is used its surface should be protected from the pressure of the threads by a wrapping of adhesive plaster.

A case being treated by continuous dilatation should receive a urinary antiseptic (as hexamethylenamine, 40 to 60 grains a day). The bougie or catheter should be removed daily and the urethra irrigated. A freshly sterilized instrument should then be inserted, preferably one a little larger than the one previously worn.

An inlying filiform bougie should extend through the stricture; it is not essential or desirable that it extend into the bladder. A catheter used in this manner should be so placed that its eye lies just within the bladder, this position being recognized by the fact that, while urine flows through it while in this position, if it is drawn further out the flow ceases.

The treatment is most easily carried out with the patient in bed, but can usually be utilized in ambulant cases with a little trouble.

Bougies cause more annoyance than catheters, as urine leaks beside them to a greater extent. (No fear need be entertained that the patient will not be able to urinate; the instrument tends to relax the spasm, and the wearer can always pass his water with ease.) For this reason a dressing must be arranged to absorb the overflow; a gonorrhœal bag makes a convenient holder for such a dressing. Catheters, in ambulant cases, must, of course, be clamped;

when used in bed-patients they may be attached to rubber tubing leading to a bottle at the side of the bed.

URETHROTOMY

A stricture may be divided entirely from within the urethra, in which case the operation is termed INTERNAL URETHROTOMY; it may be divided by an incision carried through the overlying integument and fascia—EXTERNAL URETHROTOMY; or both of these methods may be employed—COMBINED INTERNAL AND EXTERNAL URETHROTOMY. The division of narrowings at or near the meatus is spoken of as meatotomy.

MEATOTOMY.—This operation may be required in connection with more extensive stricture-division, or as the sole operative procedure. When enlargement of the meatus is necessary it is the only method to be considered, as attempts at dilatation are not only painful but quite unavailing. Under local anæsthesia it is performed as follows:

Eucaine (4 per cent.) is applied to the interior of the meatus by means of a cotton-wrapped applicator. This is removed after a minute, and the needle of a hypodermic syringe filled with eucaine solution (1 per cent.) is inserted into the floor of the urethra just within the meatus, and the region of the obstruction thoroughly infiltrated. The application of a 10 per cent. solution of cocaine on cotton to the interior of the meatus sometimes produces anæsthesia, but is not so reliable as the method described. An incision is then made with a meatotome or blunt tenotome in the median line (on the floor) of sufficient extent to allow a bougie à boule of the desired size to pass freely. After meatotomy the size should be between 28 and 38 F., according to the condition of the remainder of the urethra, it not being desirable that the meatus should be larger than the remainder of the canal. Sounds should be passed twice a week to prevent the cut surfaces reuniting.

INTERNAL URETHROTOMY.—The different methods employed in the internal division of stricture depend upon the direction and location of the incision. This may be made (*a*) from before backward or (*b*) from behind forward; (*c*) on the roof or (*d*) on the floor of the urethra.

Indications for the Performance of Internal Urethrotomy.—This operation is indicated: 1. In all strictures at or near the meatus.

2. In fibrous, resilient, or irritable strictures of large calibre anterior to the bulbomembranous juncture.

3. In strictures of small calibre situated in advance of the bulbomembranous juncture, except when such strictures are very recent, soft, and dilatable.

Or, still further to simplify the indications, it may be stated that all fibrous, resilient, or irritable strictures anterior to the bulbomembranous juncture should be treated by internal urethrotomy.

Resiliency and resistance to dilatation are the chief indications for preferring the cutting operation in the treatment of strictures of any portion of the urethral tract; hence, even though the coarctations are of large calibre, if they are distinctly resilient or fibrous urethrotomy is indicated.

Strictures of small calibre situated in advance of the bulbomembranous juncture, unless seen very early and found to be soft and dilatable, furnish the typical condition for internal urethrotomy. In such cases the operation is attended with the greatest prospect of a permanent cure. The exceptions to this rule will be given in the section devoted to combined internal and external urethrotomy.

Technique of the Operation.—The antiseptic details required in internal

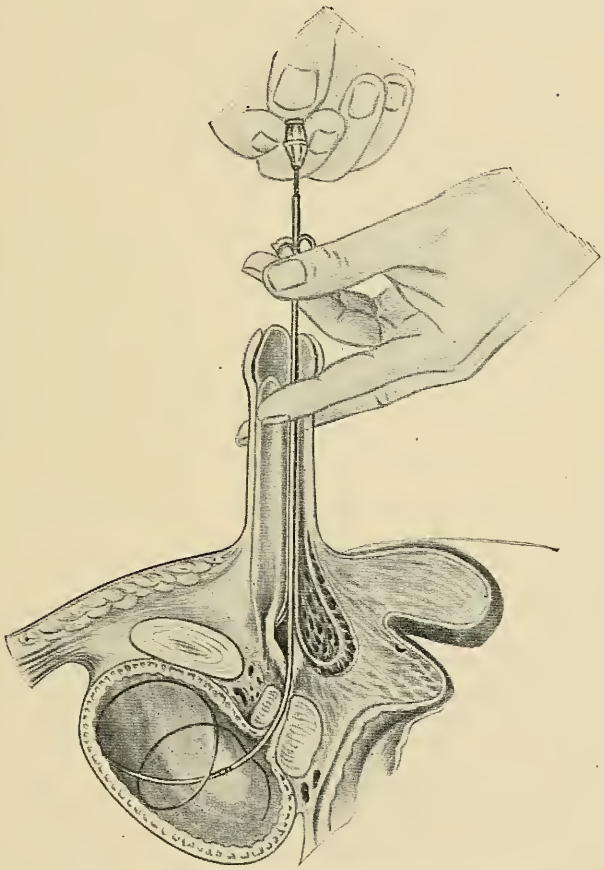


FIG. 145.—Urethrotomy with Maisonneuve's urethrotome.

urethrotomy are as follows: For two days before operation hexamethylenamine (40 to 60 grains a day) should be given by the mouth. This is particularly indicated when cystitis is present and the urine is infected. The urethra is rendered as surgically clean as possible by irrigation repeated night and morning for several days before operation, with a final washing just before the introduction of the urethrotome. The solutions used are normal saline, a 1 to 4000 lotion of potassium permanganate, a 1 to 5000 solution of silver nitrate, or a 1 to 1000 protargol solution. If the stricture is permeable, a soft

catheter of small calibre is passed behind it and the whole urethra is flushed out with the cleansing lotion, from eight ounces to a pint being used each time; or the washing is conducted with the gravity bag and short urethral nozzle.

Internal Urethrotomy from Before Backward.—This operation is indicated for strictures smaller than 15 F.; that is, those which are too small to admit the Gerster instrument. The best instrument for its performance is Maisonneuve's urethrotome. This is provided with screw-ended filiform woven bougies, which are first passed through the stricture into the bladder. The filiform is then screwed to the urethrotome, and the latter is introduced, thus accurately guided.

The knife consists of a triangular blade on a long, wire-like handle, designed to slide in a groove on the upper side of the instrument. Three knives are usually provided, cutting to 16 F., 18 F., and 20 F., respectively. The staff of the instrument has a calibre of 8 F.

The operation is performed as follows: The guiding bougie is passed into the bladder. The screw end of this is secured to the urethrotome and the tip of the latter is passed through the stricture into the bladder and held in position by an assistant. The operator with his left hand draws the penis upward and with his right hand pushes the knife down till the bulbomembranous juncture is reached, cutting on the way any obstructions that may be encountered (Fig. 145). When the strictures are comparatively soft the largest knife may be used; otherwise, the smallest knife should be used first and followed by one of larger size.

In internal urethrotomy the Maisonneuve instrument is to be considered as a preliminary to further cutting, as the result is satisfactory only when a stricture is freely divided, giving the urethra its full calibre.

Internal Urethrotomy from Behind Forward.—Among the many instruments, that of Gerster is the most convenient. The extent to which the cut shall be made is determined by the divergence of two oval blades near the tip of the instrument, the extent of their divergence being regulated by a screw on the handle of the instrument, while a finger on the side registered the calibre attained. The knife is concealed in the tip till ready for use, when it is drawn out and the stricture divided.

The operation is begun by passing the instrument to the desired depth with the dilating blades closed and the knife sheathed, and opening the blades by turning the milled wheel on the handle till the desired size is attained (an increase of more than eight or ten numbers should not be made at one cut, as the knife would not then reach the part of the stricture impinging on the blades). While an assistant draws the penis upward with the meatus exactly in the sagittal plane of the body, the operator draws the urethrotome upward till an obstruction is encountered. The knife is then drawn out of its sheath and returned (Fig. 146), the manœuvre being repeated as often as may be necessary to divide the stricture. Strictures situated farther forward are divided in a similar manner as they are reached. If the desired size has not been attained, the urethrotome is again introduced, the blades separated further, and the operation repeated. When full calibre has been attained, as indicated by

the scale on the instrument, a full-sized sound is passed to establish the fact beyond all doubt. The operation is concluded by gentle irrigation of the urethra, and the insertion and retention of a large soft-rubber catheter. A catheter is kept in the urethra for one, two, or three days, according to the reaction excited. Each day it is attached to a fountain syringe filled with protargol (1 to 2000)

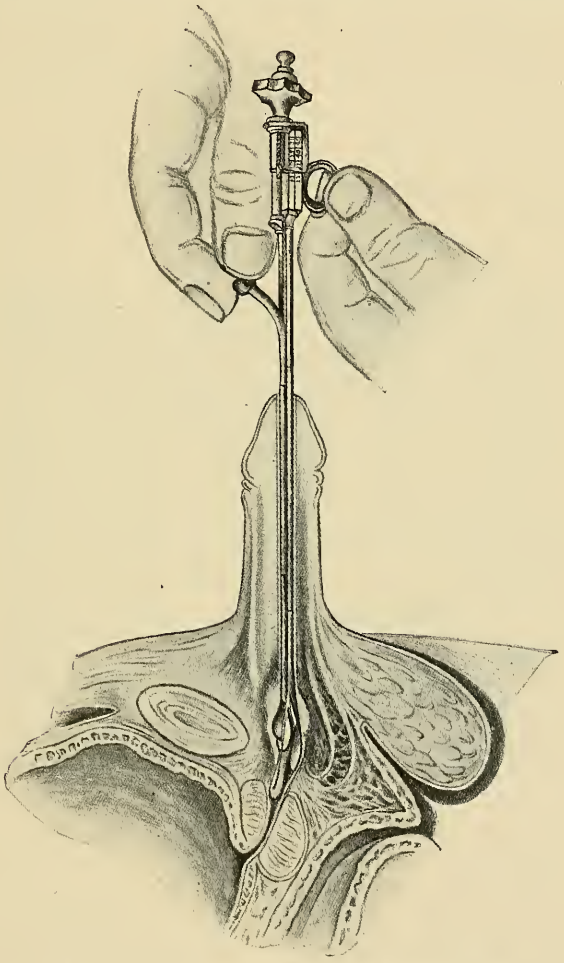


FIG. 146.—Urethrotomy with Gerster's urethrotome.

or some similar solution, and withdrawn till the solution flows out of the meatus beside it, after which it is replaced and secured in its former position.

Urinary antiseptics should be continued during the first week after urethrotomy.

The essential feature of the operation is that a linear incision should be made in the roof of the urethra (except at or near the meatus or in the membranous urethra) through every portion of stricture tissue, the cut extending from the normal parts behind to the normal parts in front of the stricture and enabling the

surgeon to pass at once an instrument two sizes larger than the normal calibre of the urethra.

If the hemorrhage is not controlled by the catheter alone, a firm bandage should be applied to the penis, or, if the point of cutting is too deep to be reached in this way, pressure may be applied to the perineum by a compress placed over the seat of operation and the application of a crossed of the perineum bandage (Fig. 147 and p. 316). For the temporary arrest of active hemorrhage perineal pressure applied by a padded cane, the ferrule of which is braced against the foot-board of the bed, will be found efficient, or digital compression may be made by an attendant.

In children internal urethrotomy has the same applications as in the adult, but the urethrotome must be modified in calibre and length to suit the age of the individual patient.

External Perineal Urethrotomy.—By this operation the urethra is

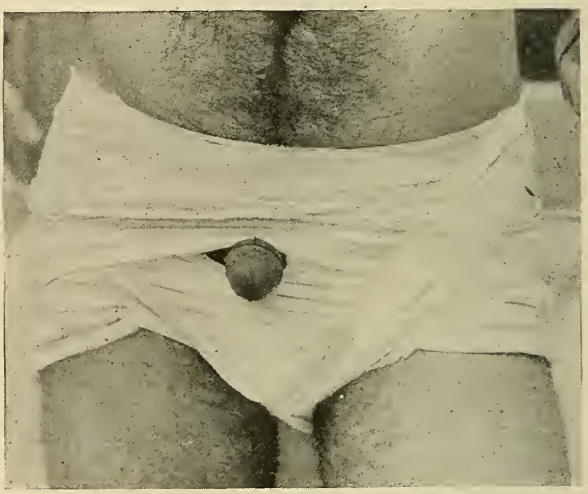


Fig. 147.—Crossed of the perineum bandage.

opened by an incision carried inward from the skin surface of the perineum. In accordance with the calibre of the stricture, certain modifications will be necessary in the performance of this operation.

Thus, if the stricture is permeable, 1, *external perineal urethrotomy with a guide,* or *Syme's operation,* is indicated, a grooved staff being carried through the narrowing and the incision made on this.

If the stricture is impermeable, 2, *external perineal urethrotomy without a guide, or "perineal section,"* is indicated, a staff being carried down to the anterior face of the stricture and the urethra being opened at this point; subsequently, aided by sight, the stricture is divided from before backward.

The general indication for external urethrotomy is the existence in the deep urethra—*i.e.,* at or posterior to the bulbomembranous juncture—of a stricture not amenable to dilatation. Under this head will come a great variety of strictures, which may be classified as follows:

1. Stricture which is resilient or so densely fibrous that it will not yield to either continuous or intermittent dilatation. Traumatic stricture is typical of this class of cases. 2. Stricture behind which extravasation of urine has occurred. 3. Stricture complicated with perineal abscess, the latter being laid open at the same time that the stricture is divided. 4. Stricture complicated with fistulæ which do not close after full dilatation. 5. Stricture complicated with a cystitis so intense that continuous drainage of the bladder is indicated. 6. Stricture associated with enlargement of the prostate and refusing to yield to dilatation. 7. Stricture complicated with retention of urine or with the "incontinence of retention." The high degree of atony of the bladder which ordinarily exists in these cases renders perineal drainage exceptionally desirable. 8. Stricture in which urethral fever follows instrumentation, or in which renal congestion or nephritis is known to exist.

External Perineal Urethrotomy with a Guide, or Syme's Operation.—Syme's staff (Fig. 148) has a narrowed terminal part which is passed through the stricture. Where this narrow portion joins the shaft there is a shoulder, which rests against the anterior face of the stricture when the instrument is in position. The patient is placed in the lithotomy position after the introduction of the staff.

The use of the Syme staff is possible only when the stricture will admit at

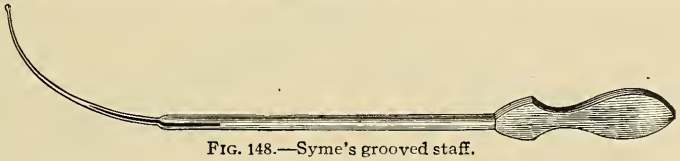


FIG. 148.—Syme's grooved staff.

least a No. 6 F. instrument; when it is so tight that nothing larger than a filiform bougie can be passed, a grooved staff similar to Syme's, but with a quarter of an inch of its extremity bridged over so as to convert the groove into a canal, a "tunnelled catheter staff" is used, and is threaded over a filiform bougie.

In whatever way the staff has been passed, the assistant who holds it is directed to make its convexity bulge in the perineum. The left forefinger of the operator is inserted into the rectum, and an incision is made one inch in front of the anus and exactly in the median line of the perineum. This incision is deepened till the knife-point enters the groove of the narrow part of the staff, usually behind the stricture. The latter is then divided by cutting from behind forward until the projecting shoulder of the staff is freed and passes onward towards the bladder without difficulty. A director or Teale's probe gorget (Fig. 149) is now introduced along the groove of the staff into the bladder, and the staff is withdrawn. Finally, a rubber catheter, No. 24 to No. 28 F., is passed from the meatus into the bladder, guided by the director or gorget, and aided in its course by manipulation through the wound. The catheter is retained for one, two, or three days, according to the reaction excited. In from five to seven days a full-sized sound is passed through the penile urethra into the bladder, and this is repeated every third day for a month, after which the intervals between instrumentation may be made progressively longer.

If the filiform passes, but the tip of the tunnelled staff cannot be forced through the stricture, the latter is held in contact with the anterior surface of the narrowing by an assistant, and is exposed by a free incision in the median line of the perineum, splitting the urethra in front of the stricture; a loop of silk is then passed through each edge of the divided urethra close to the face of the narrowing, thus enabling the canal to be held open. The staff is withdrawn a litte in order to bring the black filiform into view, and then the stricture is divided from before backward, together with half an inch of the uncontracted canal behind it. The last step consists in passing the staff, guided by the filiform, into the bladder. The subsequent treatment is the same as in Syme's operation.

The Prognosis of Stricture after External Perineal Urethrotomy.—The thorough division of stricture by external urethrotomy occasionally results in cure without further treatment. This, according to Guyon, is because the elastic fibres of the urethra run circularly; when cut they retract, and restoration of the urethral lumen is accomplished by means of a wide scar, which usually does not contract sufficiently to produce stricture again.

It is possible that recent strictures unattended by submucous fibroid infiltration can be cured by either gradual dilatation or section. When there is distinct

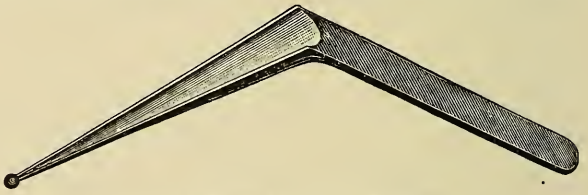


Fig. 149.—Teale's probe-ended gorget.

fibroid periurethral infiltration, with decided alteration of the mucous membrane, section, followed by a prolonged course of gradual dilatation, will usually accomplish a practical but not a truly radical cure. In densely fibrous nodular stricture a radical cure can be attempted only by means of excision, and even then will probably not be attained: hence, though a stricture be cut, either internally or externally, the intermittent use of the sound for a long period should be advised.

Combined Internal and External Urethrotomy.—This operation is described by Reginal Harrison, its chief advocate, as follows: The stricture is divided by means of a urethrotome. The patient is then placed in the lithotomy position, a grooved staff is introduced, and, with a long, straight knife entered one inch in front of the anus, the membranous urethra is punctured, the back of the knife being towards the rectum. The incision is slightly enlarged forward, to permit the introduction of the index finger. If the staff is not fully exposed, a somewhat dull though pointed knife is introduced along the finger, and the tissue still remaining between the tip of the finger and the groove is cleared away. If a sharp knife is used, there is danger of making the incision unnecessarily large or of cutting the finger. The incision is planned first to fit the finger and afterwards the drainage-tube. When the groove of the staff is

felt, a probe-tipped gorget is slid along it, the staff is removed, and a drainage-tube is passed along the concavity of the gorget into the bladder. This tube drains the bladder directly, giving the urethra physiological rest. It is retained seven to ten days; after the second day it is taken out and cleansed daily, and the bladder is irrigated twice daily with a 1 to 10,000 or 1 to 5000 sublimate solution.

This operation possesses the advantage of preventing the freshly cut stricture from being irritated by the urine. Since contact with urine is an essential factor in the production of organic stricture, such a diversion of the stream during attempts at radical cure is worthy of consideration whenever resilient, nodular, or traumatic anterior strictures are cut, or whenever the coarctation is complicated by fistulæ; physiological rest is thus obtained for the whole region, and the inflammatory products in the wall of the urethra are allowed to undergo fatty degeneration and absorption.

Harrison particularly recommends his operation in cicatricial, contractile, and relapsing strictures seated in the deeper part of the urethra, claiming for it the following advantages: 1. It is applicable to the worst forms of urethral strictures. 2. It guards against rigors, fevers, and the complications which tend to rise from these. 3. It tends to improve permanently the condition of the stricture.

Experience has shown that if the tissues can be freed from every source of irritation and can be given physiological rest for a long period, hardened lymph will disappear and the urethral walls again will become soft and yielding. Drainage by perineal opening is the only way in which complete rest can be given to the strictured region.

Perineal Section.—This operation is reserved for strictures through which the smallest instrument cannot be made to pass. Such strictures, whether gonorrhœal or traumatic, are usually deeply seated, and are approached through the perineum.

A special hooked staff (Wheelhouse's) is required, in addition to a probe-tipped gorget, scalpel, forceps, needles, etc. The patient is placed in the lithotomy position, and the staff is introduced with the groove towards the floor of the urethra, its hooked extremity being brought gently into contact with the stricture. No force is permissible, since the urethra in these cases is readily torn. While an assistant holds the staff in position, an incision is made in the perineum, and the urethra is exposed, and is opened in the groove of the staff, not upon its point, thus making the incision at least a quarter of an inch in front of the stricture, since the groove is not continued to the hook-shaped extremity of the staff. Through the edges of the urethral incision are passed by means of curved needles stout silk threads, one on each side, forming loops, by drawing on which the urethral walls are retracted. The staff is gently withdrawn until the button point appears in the wound. It is then turned around so that the groove faces the roof, and the button is hooked in the upper angle of the open urethra. The urethra is now stretched open at three points just in front of the stricture. The button on the staff, however, is often in the way, and, if so, this instrument should be withdrawn. With the anterior surface of the stricture thus exposed, the narrow opening through it is often seen, and a

probe-pointed director is passed without difficulty. Even if warty growths or granulations conceal the position of the narrowed channel, careful probing with the director usually results in the ready passage of the latter into the bladder. The groove of the director is then turned downward, and along it the whole length of the stricture is carefully and fully divided, this part of the operation being completed by running a straight probe-pointed bistoury along the groove to insure the cutting of every band. Teale's gorget is now passed along the groove of the director into the bladder, and the director is withdrawn. The object of the gorget is to facilitate the introduction of catheters into the bladder, at times a most difficult procedure after perineal section. A full-sized soft rubber catheter is passed from the meatus into the bladder, the gorget is withdrawn, and the catheter is fastened in the urethra. After three or four days the catheter is removed. Sounds are then passed every third day, until the wound in the perineum is healed, and after that from time to time to prevent recontraction.

If the probe-pointed director does not find the opening through the stricture, the operation must be continued by dissection until the urethra is fairly opened. If the bladder contains urine, pressure on the hypogastrium, or bimanual pressure, one hand being placed on the abdomen and a finger of the other in the rectum, will often cause the expulsion of some urine, and thus show the opening through the stricture. The use of very hot water will sometimes be of service by emphasizing the difference in color between the surrounding parts and the urethra, the latter being much paler.

The operation requires a good light, and often much patience.

Retrograde Catheterization.—When all guides fail, and when after perineal section the proximal end of the urethra cannot be found, as in cases of traumatic stricture with practical obliteration of the canal, a suprapubic cystotomy and retrograde catheterization are indicated. The slight additional risk is far outweighed by the advantages to the patient of having even an imperfect restoration of the urethral canal.

In performing retrograde catheterization the suprapubic opening into the bladder is made sufficiently large to admit the finger; guided by the latter, which can readily feel the vesical orifice of the urethra, a steel sound or a silver catheter is introduced from behind forward till its tip becomes apparent through the perineal opening. When the belly is prominent it may be difficult to pass an ordinary sound, by way of the small vesical opening, into and through the prostatic and membranous portions of the urethra. To obviate this difficulty Guyon has suggested an instrument with a longer or more complete curve; in the absence of this, a gum catheter, provided with a stylet and with the required curve given it may be employed. As soon as the tip is freely exposed through the perineal wound, a soft catheter, the end of which has been cut off, is slipped over it; on withdrawing the sound this catheter is carried from the perineum through the suprapubic opening. A sound having been passed from the meatus to the perineal wound, the other end of the soft catheter is forcibly pushed over its tip and is drawn forward till it projects from the meatus; or a catheter may be passed in from the meatus in the same manner as in external urethrotomy. The tube is left in place for from five to seven days.

Excision.—The resection of the strictured part of the urethra requires free incision, not only for the removal of the strictured area, but for the mobilization of sufficient of the remaining urethra to permit suture of the ends. It is a difficult operation, and is only indicated in traumatic strictures, and after the failure of simpler measures. The transplantation of epithelium may be necessary in some cases.

Stout has advocated the removal of the fibrous tissue surrounding the canal without the actual opening of the urethra. He reports good results from the procedure.

SUMMARY OF TREATMENT

1. **Gradual dilatation** is indicated as the treatment of choice in all recent, soft, or dilatable strictures found in any part of the urethra, without regard to the calibre of such strictures.

2. **Continuous dilatation** is indicated in uncomplicated strictures which are so tight that no instrument larger than a filiform can be made to pass. This continuous dilatation is practised till a small metal or woven instrument can be introduced—No. 12 to No. 16 F. Then the normal calibre of the urethra is restored by gradual dilatation or by cutting, in accordance with the nature and the clinical behavior of the stricture.

3. **Internal urethrotomy** is indicated in all fibrous, irritable, and resilient strictures anterior to the bulbomembranous juncture. Narrowings at or near the meatus should be treated by the knife whenever it is apparent that they are responsible for definite symptoms. The division is here made on the *floor* of the urethra. All other anterior strictures are divided along the *roof*.

4. **External perineal urethrotomy** is indicated in all fibrous, resilient, or irritable strictures situated at or behind the bulbomembranous juncture.

5. **Combined internal and external urethrotomy** is indicated in the treatment of *anterior* strictures which are unusually dense or nodular or which are complicated by fistulæ.

6. **Perineal section**, or external perineal urethrotomy without a guide, is indicated in the treatment of impassable stricture of the deep urethra. When the proximal urethral end cannot be found, *suprapubic cystotomy* and *retrograde catheterization* are in order.

7. **Excision** is indicated in cases of impermeable stricture, nodular or fibroid, where there has been complete destruction of mucous membrane. When so much tissue is removed that it is impossible to bring the divided urethral ends in apposition, *transplantation* of mucous membrane is indicated.

STRICTURE OF THE FEMALE URETHRA

Stricture of the female urethra is comparatively rare. In cause and symptoms it corresponds with the like condition of the male urethra. It may be congenital or acquired, and the acquired stricture may be spasmodic, inflammatory, or organic. The congenital stricture is, as in the case of the male, usually placed at or near the urinary meatus.

Spasmodic stricture, that due to muscular spasm, is more frequent than in the male. This is doubtless owing to the greater reflex susceptibility of women.

Familiar examples are afforded by retention of urine due to fright, exhaustion, exposure, urethritis, caruncles, etc.

Inflammatory stricture—*i.e.*, encroachment on the urethral calibre by acute inflammatory swelling—probably never becomes sufficiently marked to produce retention, this when it occurs being due to spasm reflexly excited from the hyperæmic and hyperæsthetic areas.

Organic stricture is due to trauma, commonly inflicted during childbirth, or to inflammation, usually gonorrhœal in nature, but is sometimes occasioned by a urethral calculus, or by the virus of chancre or chancroid, or by irritating applications. The urethral narrowing is due to the contraction of the fibrous tissue which has been deposited in the walls of the canal as an inflammatory infiltrate and which has subsequently become organized. Hermann states that in old women there is found stricture due to general fibroid thickening of the urethra, occurring without any history of gonorrhœa or other discernible cause. The seats of narrowing are oftenest at or near the meatus and near the neck of the bladder. The stricture is usually single, and frequently occasions so little inconvenience that its presence is not suspected by the patient.

Skene states that organic stricture sometimes occurs at the juncture of the urethra with the bladder, and that even though it be of large calibre it occasions symptoms out of all proportion to the amount of narrowing it produces; this is probably because there is infiltration of the vesical sphincter and interference with its function. Difficult urination and retention are the most characteristic symptoms, the stricture being of such a large calibre that it may escape detection by the bulbous bougie.

Symptoms.—The symptoms of stricture in women are frequent urination, dribbling after the act, the passage of an irregular stream, and often urethral discharge.

At times the only symptom is an occasional attack of retention of urine occasioned by slight causes, such as exposure or fatigue, and usually ascribed to muscular spasm. Though the spasmodic element is in these cases always the exciting cause of the retention, the predisposing cause will occasionally be found to be a urethral stricture of large calibre.

Difficult urination and sometimes retention particularly characterize stricture at the juncture of the urethra and the bladder.

Diagnosis.—The diagnosis is made by careful examination of the floor of the urethra by means of a finger introduced into the vagina and by the passage of bulbous bougies. By the vaginal touch cicatricial induration of any part of the urethra, if marked, can be found. This is the most reliable method of detecting the stricture of the neck of the bladder, described by Skene, since the narrowing may be so slight that a comparatively large instrument may pass through readily.

In passing the bulbous bougie it must be borne in mind that the urethra in women has two points of physiological narrowing,—*i.e.*, the meatus and the neck of the bladder; the canal between these points admits of wide dilatation. If a very large bulbous bougie is introduced, the resistance offered to the inward or outward passage of the instrument by the seats of normal narrowing might readily be mistaken for that due to organic stricture.

Prognosis.—The prognosis of stricture of the urethra in women is much better than is the case with men. The narrowing rarely reaches such a degree that the function of micturition is greatly interfered with, and hence the train of vesical, renal, and general vascular changes which ultimately result fatally is rarely inaugurated. In exceptional cases when the urethral calibre is markedly encroached on, and the condition is unrelieved, the prognosis is the same as for men.

Treatment.—Congenital or inflammatory narrowings of the meatus should be cut freely, the normal calibre being maintained by the use of a meatus bougie. The directions given for the performance of meatotomy in the male obtain in these cases. Soft, recent, dilatable strictures are gradually cured by short straight steel sounds. Dense, traumatic, nodular, irritable, or resilient strictures are treated by internal urethrotomy. When the urethra is totally obliterated at one point the propriety of excision and of mucous membrane transplantation may be considered.

CHAPTER XIV

SURGERY OF THE SCROTUM

ANATOMY, DEFORMITIES, INJURIES AND WOUNDS. ŒDEMA, EMPHYSEMA, CUTANEOUS AFFECTIONS. GANGRENE. ELEPHANTIASIS. TUMORS.

ANATOMY

The scrotum is a pouch of skin and fibromuscular tissue, the dartos.

The skin is provided with numerous sebaceous follicles and a small number of hairs, and after maturity becomes pigmented. It generally exhibits folds or rugæ passing at right angles to the median raphe.

The dartos is composed of connective tissue and smooth muscular fibres. It is continuous with the superficial fascia of the groin and perineum, and forms at a position corresponding to the raphe an incomplete septum partially separating the two sides. The dartos is closely attached to the skin, and is abundantly supplied with blood-vessels. By its contraction it draws the skin of the scrotum into folds and holds the testicles up near the position of the external rings. The contraction of this muscular tissue is occasioned by sexual excitement, by cold, or by mechanical stimuli.

Beneath the dartos there is a layer of loose cellular tissue on which the skin and dartos are freely movable, and into the meshes of which blood effusions or dropsies may readily occur.

The blood-supply to the scrotum is derived from the external pudic arteries, the superficial branch of the internal pudic and the cremasteric arteries. The lymphatics are received by the inguinal nodes.

The points of practical value to be gathered from a consideration of the anatomy of the scrotum are: (1) from the close attachment of the dartos to the skin, the latter when wounded is liable to be inverted, thus making perfect apposition difficult in suturing incisions of this portion of the body; (2) in consequence of the loose texture of the cellular tissue lying within the dartos and the abundant vascularity of the scrotum, bleeding incident to traumatism is free and is likely to form large accumulations; (3) on account of this same arrangement, œdema of the scrotum is pronounced from comparatively slight causes, and septic infection spreads quickly and sloughs widely.

Deformities

Congenital deformities of the scrotum unaccompanied by malformation of the penis or malposition of the testicles are practically unknown. With hypospadia and pseudohermaphroditism the raphe becomes converted into a distinct cleft, dividing the scrotum into two halves, much like the labia majora. When there is an undescended testicle the scrotum usually does not develop on the affected side, thus producing some asymmetry. At times adhesions binding together the scrotum and the penis are noted at birth.

DISEASES OF THE SCROTUM

Injuries of the Scrotum.—Contusions may be extensive without involvement of the testicles, these organs readily slipping from the direct line of pressure. Such injuries are followed by rapid swelling, extensive subcutaneous blood effusions, and intense discoloration. They should be treated by thorough preliminary cleansing of the skin, rest, pressure, and the application of evaporating lotions. Under such treatment suppuration does not take place. When the skin is not clean, and especially when it becomes abraded, extensive and obstinate suppuration may occur.

Wounds of the scrotum are treated upon the general principles applicable to wounds of other portions of the body. Hæmostasis should be complete before closure, since the vessels are without support, and if not secured may bleed into the loose cellular tissue, forming large accumulations of blood.

At the time of suture the borders of the wound must be so approximated that the tendency to inversion of the skin shall be overcome. Catgut, silk, and horse-hair are the best suture materials; a continuous glover's suture applied close to the wound edges answers well.

After closure and aseptic dressing, the scrotum should be supported by means of a suspensory bandage, or jock-strap, or crossed of the perineum roller.

Œdema of the scrotum may be an expression of general anasarca due to lesions of the heart and kidneys, in which case it is usually pronounced, and in some instances first calls attention to the central lesion, or it may be due to inflammation of the overlying skin or of the testicles, local interference with circulation, as from lymphadenitis of the groin, infiltration of urine, rupture of a hydrocele, or septic infection. Simple œdema sometimes threatens the vitality of the part; in this case tension is relieved by multiple needle-punctures made under the strictest antiseptic precautions. Inflammatory œdema is treated by attacking the cause of inflammation,—evacuating the extravasated urine by incisions, for instance, or opening abscesses.

Emphysema may be due to entrance of air into the loose cellular tissues through a wound, such as that produced by a trocar, or to the escape of air or gas from a hollow viscus remote from the scrotum; as, for instance, when the stomach and intestines are opened, occasioning general emphysema. More commonly it is due to gas, the result of fermentation and putrefaction *in loco*, and this in a measure is an index to the extent of sloughing or gangrene going on beneath the surface.

The treatment of emphysema when it is simply aerial and is not a symptom of extensive tissue-destruction should be conservative. When it is due to the gas of decomposition, free incisions and vigorous disinfection are required.

The cutaneous affections of the scrotum are practically those of other skin surfaces of the body, and are amenable to the same treatment. It should be borne in mind, however, that the skin of the scrotum is extremely sensitive to irritating applications, such as tincture of iodine, which if painted over this region may cause intense pain for many hours.

There are certain skin eruptions which develop on the scrotum with great frequency. Among these are erythema, intertrigo, eczema, pruritus, and pedi-

culosis. More rarely molluscum contagiosum, sebaceous cysts, pityriasis, eczema marginatum and scabies are observed.

Erythema intertrigo is very frequently observed in children and in fat, soft men, especially those who are rheumatic in tendency or are uncleanly in their habits and who are given to exercise, such as walking, which occasions friction between moist surfaces.

The treatment consists in thorough cleanliness and the interposition of a layer of soft muslin or lint between the chafing surfaces, or, better still, the application of a suspensory bandage, made of thin gauze. The parts are bathed in weak solutions of carbolic acid 1 to 200 and hydrastis canadensis 1 to 20, after which they are carefully dried and dusted with finely powdered zinc stearate powder. In some cases ointments give better results. One of the best is that of resorcin two per cent. made up with lanolin and lard equal parts.

Eczema may develop in healthy persons, though it is more frequently observed in association with the gouty or rheumatic diathesis, sometimes in connection with diabetes. It may appear in almost any of its various forms, is extremely obstinate, and causes intense itching and burning. There are frequently concomitant swelling of the whole scrotum, deepening of the transverse rugæ, and the formation of raw surfaces from which there exudes an offensive discharge.

The treatment is that generally applicable to this disease.

Among the most useful prescriptions are the following:

℞ Zinci oxidi,
Zinci carbonat., āā℥vi;
Glycerini, f℥iv;
Liquor. calcis, f℥vi.
M. S.—Shake well before applying.

This should be dabbed on for four or five minutes. In chronic cases with thickening the following may be applied (Bulkley):

℞ Picis liquidæ, ℥ii;
Potassæ causticæ, ℥i;
Aquæ f℥v.

This may be used as an antipruritic, diluted with twenty to thirty parts of water, or may be rubbed directly into the infiltration.

An excellent powder to be employed during the day is the following:

℞ Pulv. amyli, ℥vi;
Zinci oxidi, ℥iss;
Pulv. camphoræ, ℥ss;

or

℞ Thymol. gr. ii;
Pulv. zinci stearat., ℥iv.

Pityriasis.—Patients with delicate skins are occasionally annoyed in warm weather by a light-bromide discoloration of the skin of the thighs and scrotum, where these surfaces are continually in contact. The affection is further attended by considerable itching and is due to a vegetable parasite inhabiting the upper layer of the epidermis.

After washing the area with soap and drying to remove grease from the scales and spores, a few applications of sulphurous acid will effect cure.

Eczema marginatum is another parasitic disease, frequenting the thighs, scrotum, mons veneris and buttocks. This affection is not an eczema, but a combination of herpes tonsurans and intertrigo, as proved by Pick. The disease requires friction, moisture, and the filaments and spores of the tricophyton of Malinster for development. The common site, therefore, is between the scrotum and the thigh. The lesion appears as one or more small round patches, red, slightly elevated, and itchy. The sequence of the eruption is papule, vesicle, excoriation, and crust. The lesion spreads eccentrically, the periphery being sharply demarcated, characterizing the disease. As the centre heals a brownish discoloration results and the surface is studded with small collections of scales. It is refractory to treatment, and recurrences are frequent, springing from the circumference of the area first affected, necessitating the continuation of treatment after the disappearance of lesions. The best parasiticide lotion is bichloride of mercury, 1 to 10,000 or 8000, continuously applied. Pure sulphurous acid also acts well.

Pruritus is most frequently observed in rheumatic or gouty subjects. Though often associated with the lesions of pediculi, it may develop independently of these.

The treatment must be in the main systemic, though the local antipruritic applications, such as thymol, tannic acid, tar, camphor, etc., are serviceable. Prolonged hot bathing of the parts is useful.

Pediculosis ultimately excites intense pruritus, though it is often not detected for a long time. Careful examination of the scrotum shows the parasites at once. They appear as minute scabs, most abundant about the root of the penis. The ova are found on the hairs.

The application of an ointment of twenty per cent. oleate of mercury one part, petrolatum two parts, or of mercurial ointment one part, petrolatum three parts, rubbed into the scrotum every night, the excess being wiped off with a soft towel before retiring, and the whole region washed with soap and hot water the following morning, will be followed by cure in a few days.

Tincture of cocculus indicus applied freely after a warm bath and allowed to dry on the part is more cleanly and is efficacious.

Molluscum contagiosum is observed mostly in children. The lesions consist of small, waxy, almost spherical tumors or cysts, situated in the superficial layers of the skin. They are sessile, but may become pedunculated when they have existed for a considerable time without softening. At first smooth and round, they become umbilicated, exhibiting a small black spot in the centre of the depression, which indicates the opening into the follicle. They grow slowly, and occasion no pain unless complicated by inflammation.

They may disappear spontaneously, but should be removed, since they are contagious. The contents of the cyst may be squeezed out and the walls touched with pure carbolic acid. Pedunculated growths should be snipped off and their bases cauterized.

Steatomata or Sebaceous cysts have not the waxy appearance of molluscum, nor do they appear in childhood. They are usually single, but may be multiple. They are soft and doughy in consistence, and when infected break down and suppurate. They sometimes attain the size of a hen's egg. The thin overlying skin becomes adherent in inflammatory cases. Removal of the entire sac is the only effective treatment.

Gangrene of the Scrotum.—This affection, extremely rare, except as a

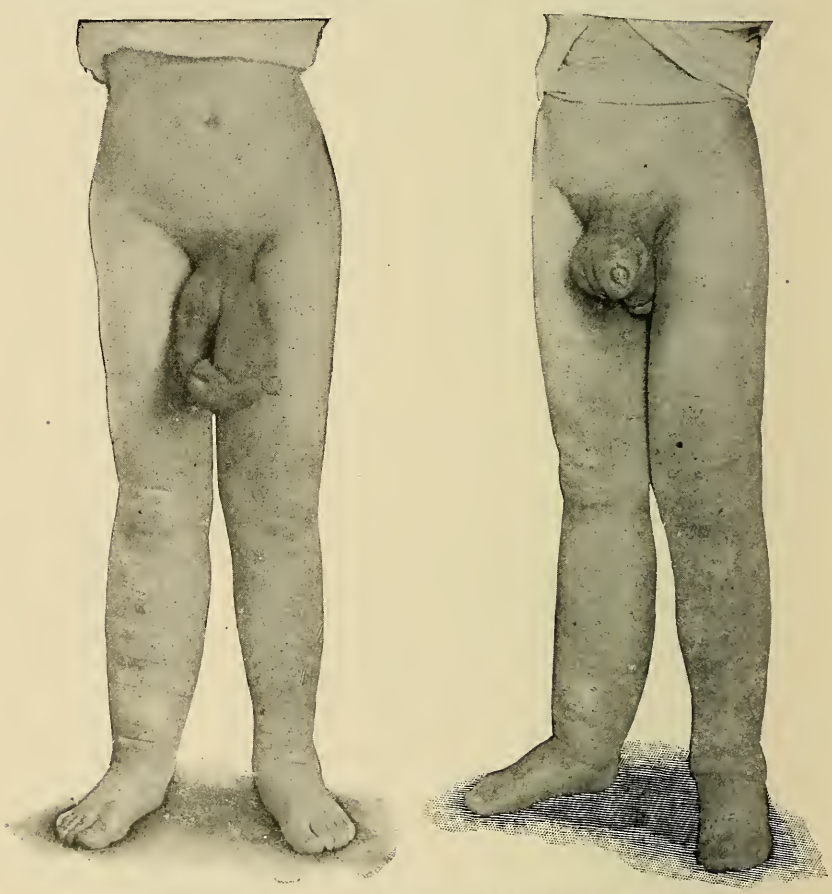


Fig. 150.—Elephantiasis of the penis and scrotum, showing the result of operation.

complication of rupture of the urethra or as a sequel of extensive traumatism, has been attributed, when it follows inflammation of the inguinal nodes or operation on these structures, to reflected nerve irritation, but is more probably due to infection with the ordinary pus microbes.

Among the causes of this condition are included urinary infiltration, erysipelas, thrombosis, embolism, and incidentally influenza, typhus and other fevers, syphilis, gonorrhœa, diabetes, prostatic disease, pediculi pubis, ergotism, traumatism (faulty punctures and injections), and frost-bite.

Even though the testicles be completely denuded, they will ultimately be covered by granulation-tissue and their function will be preserved.

Treatment.—Scrotal gangrene should be treated by hot antiseptic fomentations until the sloughs separate. The testicle should then be covered as completely as possible by suturing the remaining healthy skin, the wound being dressed daily until complete healing, with gauze wrung out of nonirritating lotions, as 4 per cent. sodium chloride. When due to urinary infiltration—the usual cause—free incisions, and direct drainage from the point of urethral rupture are indicated.

Elephantiasis, endemic in certain countries, is rare in the United States. It is generally supposed to be due to the stoppage of lymph-channels by the ova of the filaria sanguinis hominis, but in this country it has been observed in cases in which the parasite was not present in the blood, and the obstruction to the flow of lymph could be accounted for only by some preceding inflammatory condition, such as recurrent attacks of erysipelas or dermatitis, or cicatrization following syphilitic lesions or excision of the inguinal nodes.

Prunner states that the disease always begins in the form of a hard kernel under the skin, usually at the bottom of the left side of the scrotum. This spreads in all directions, forming a diffuse, hard, thick, wrinkled skin tumefaction (Fig. 150). The tumor is pyriform, and the rough, often warty, skin covering it is likely to become excoriated from the irritation of the urine. The growth may attain an enormous size, weighing as much as two hundred pounds. It is commonly associated with some degree of elephantiasis of the skin of the lower extremities. The testicles, however, remain unaffected.

Treatment.—In the early stages galvanism and the internal administration of potassium iodide may be serviceable. When the tumor attains such size as to be inconvenient from its weight, complete excision of all the diseased tissues is indicated. This operation is usually bloody, many vessels requiring ligation. The best means of checking hemorrhage during removal is to transfix the tumor at its base with long pins, and to apply behind these transfixing pins the elastic ligature. The fact that hernia frequently complicates this affection must be borne in mind in applying these transfixing pins and securing the elastic band. The penis and testicles are first freed, then all the diseased tissue is cut away. Even though the testicles are entirely denuded, this need not occasion anxiety, since they will be covered by granulation-tissue.

Tumors of the Scrotum.—Epithelioma.—Aside from sebaceous cysts, epithelioma is the most frequent form of new growth observed upon the scrotum. It is called " chimney-sweepers' cancer," because it formerly attacked by preference people engaged in this work. In recent years the method of cleaning chimneys has changed, and the name is no longer applicable.

It begins as an indurated wart, which becomes excoriated and scabby on its surface; this wart is shortly transformed into an ulcer, which is characterized by hard, raised edges, uneven surface, unhealthy granulations, and the exudation of ichorous pus. It is sometimes extremely painful, and steadily extends, ultimately involving the inguinal lymphatic glands, which soften and ulcerate. It

is stated that workers in coal-tar are especially liable to this form of disease (Fig. 151).

Treatment.—The treatment consists in the removal of the indurated tissues by an incision carried wide of the diseased area. The inguinal lymph-nodes should be removed at the same time. Thus treated early in the course of the affection the prognosis is favorable.

Fatty tumors are at times observed; they are of importance because of their intimate connection with the testicle. Diagnosis is rarely possible without

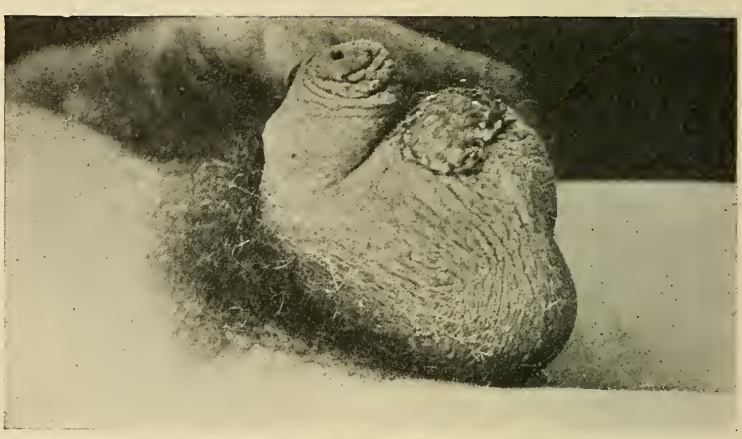


FIG. 151.—"Coal-tar worker's cancer" of the scrotum.

exploratory incision, because, on palpation, they feel almost precisely as does an irreducible omental hernia. Excision is the only treatment.

Fibromata are rarely observed. They are freely movable under the skin. They should be removed as soon as discovered, since in their development they may form adhesions to the testicle, which would make subsequent operation without injury to this gland extremely difficult. These fibrous tumors sometimes recur after removal.

Gummata, enchondromata, osteomata, and cysts are occasionally observed.

CHAPTER XV

SURGERY OF THE TESTICLES

ANATOMY

By the testicular parenchyma the spermatozoa are formed, the primary function of these organs. They also have an internal secretion which is essential for the development of the prostate and the penis, and for the characteristic male configuration, hirsutes, and restless combativeness. Testicular growth and function are profoundly influenced by the thyroid, the pituitary, the pineal, and the suprarenal glands.

In the adult the testicles are suspended in the scrotum by the spermatic cords.

Developed within the abdomen, during the latter half of fœtal life, they descend into the scrotum, being drawn down by a musculo-fibrous cord—the gubernaculum testis—which is attached above to the base of the epididymis and below to the scrotum. Lockwood states that at the sixth to the eighth month of intra-uterine life many of the lower fibres extend into Scarpa's triangle and the perineum; this may explain the occasional presence of the testicle in these regions.

The testis is a gland of oval form; it is hung obliquely in the scrotum, the upper extremity being directed somewhat forward. (Figs. 152, 153.) It has flattened sides and is of variable dimensions, but commonly is one and a half inches long, an inch broad, and an inch and a quarter from behind forward. The weight of each gland is from three-quarters of an ounce to one ounce, and the left is somewhat larger than the right.

The tunica vaginalis is derived from the peritoneum during the descent of the testicle in fœtal life. It is the serous covering of the testis, and is composed of two layers,—an inner visceral and an outer parietal. The inner visceral portion forms a close investment for the testicle and epididymis, while the outer parietal portion is a loose sac investing the testis and extending for some distance up the cord. The true capsule of the testicle is the tunica albuginea. This is a tough covering, composed of interlacing bundles of white fibrous tissue. It is covered everywhere by the tunica vaginalis (Plate VIII), except at the points of attachment to the epididymis. At the posterior portion of the gland the tunica albuginea is inverted into the interior and forms an imperfect septum,—the mediastinum. It extends from the upper nearly to the lower border of the gland; from it numerous trabeculæ radiate towards the surface of the testicle, dividing the interior of the latter into many spaces, conical in shape, with their bases towards the surface. The trabeculæ serve to maintain the general shape of the organ, to convey the numerous blood-vessels that ramify in its interior, and act as supports to the glandular structure of the testicle, which is made up of lobules.

These lobules, in accordance with the arrangement of the trabeculæ, which in each testicle have been variously estimated at from one hundred and fifty to four hundred in number, are pyramidal in shape. (Fig. 154.) According to their size, the glandular lobules are made up of three or more convoluted seminiferous tubes, variously estimated as being from two to sixteen feet in length. It is in these tubes that the spermatoblasts which subsequently become converted into spermatozoa are formed. The tubes begin in cæcal extremities, or

Fig. 152.

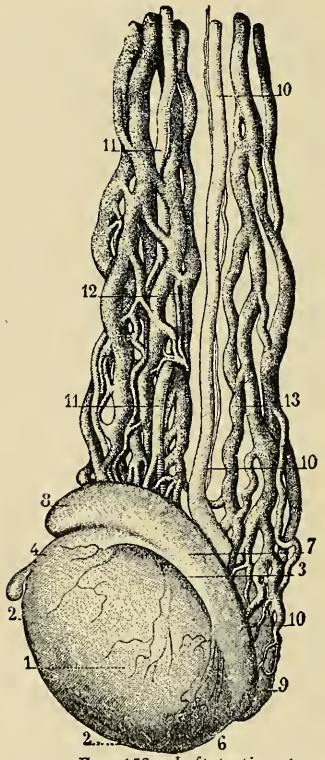


Fig. 153.

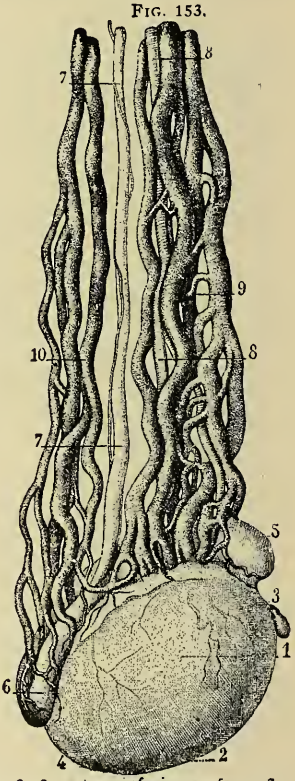
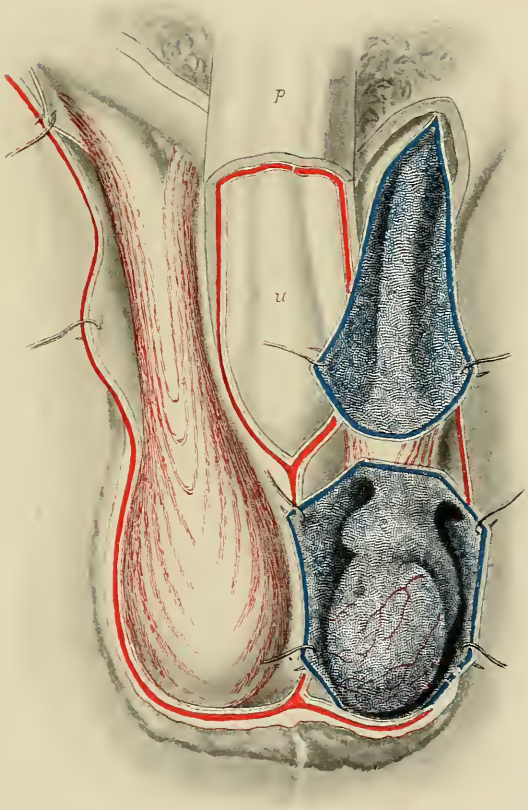


Fig. 152.—Left testis. 1, outer surface; 2, 2, antero-inferior surface; 3, postero-superior surface; 4, upper extremity, with hydatid of Morgagni; 6, postero-inferior extremity; 7, epididymis; 8, its head; 9, its tail; 10, 10, 10, deferent canal 11, 11, spermatic artery; 12, anterior spermatic veins surrounding the artery; 13, posterior spermatic veins.

Fig. 153.—Left testis. 1, inner surface; 2, antero-inferior surface; 3, upper extremity surmounted by Morgagni's hydatid; 4, posterior-infero surface; 5, head of the epididymis; 6, tail; 7, 7, deferent canal accompanied by the deferential artery; 8, 8, spermatic artery; 9, anterior spermatic plexus; 10, posterior spermatic plexus. (Sappey.)

intercommunicate with other tubes; as they approach the apices of the cones they become much less convoluted, finally uniting to form twenty or thirty ducts, which from their straight course are named the vasa recta. These vessels pass upward and backward, penetrate the mediastinum, and form an anastomotic net-work made up of channels in the fibrous tissue without proper walls and termed the rete testis. These channels terminate at the upper end of the mediastinum in twelve to twenty ducts, called the vasa efferentia, which per-

PLATE VIII.



Showing the relations and coverings of the testicle and epididymis. (Testut.)
P. Penis. *U.* Urethra. *C.* Spermatic cord. *E.* Epididymis. *T.* Testicle.

forate the tunica albuginea, and convey the seminal secretion to the upper part of the epididymis; they are at first straight, but subsequently become enlarged and convoluted, forming the coni vasculosi, which collectively constitute the globus major, or upper enlargement of the epididymis (Fig. 155). The efferent vessels finally open into a single duct, the canal of the epididymis, which constitutes by its convolutions the body and globus minor of the epididymis, measuring in its natural state about three inches in length, but when unravelled nearly twenty feet. The convolutions are held together by areolar tissue; the interior of the canal is lined by columnar ciliated epithelium.

In fœtal life the head of the epididymis, its canal, the vas deferens, and the ejaculatory duct are formed from the canals and ducts of the Wolffian body. The vas aberrans is formed from the same body, persisting as a canal, running upward from the lower part of the epididymis or the commencement of the

Fig. 154.

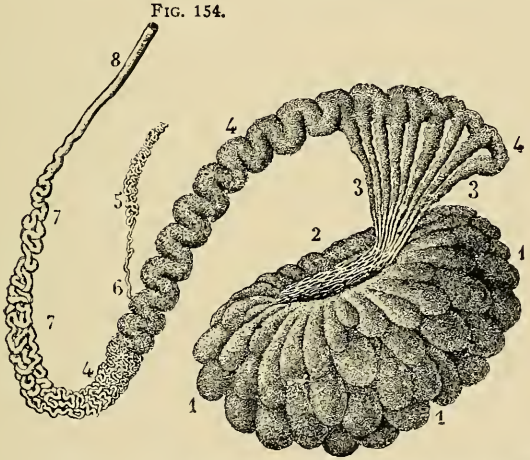


Fig. 155.

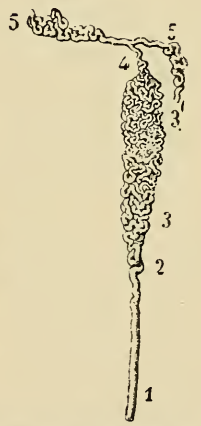


Fig. 154.—The lobules of the testis, the rete testis, the efferent vessels, and the epididymis. 1, 1, 1, seminiferous lobules of the testis; 2, rete testis; 3, 3, efferent canals, the coni vasculosi, collectively forming the head of the epididymis; 4, 4, 4, canal of the epididymis; 5, vas aberrans; 6, its entrance into the epididymis; 7, origin of the convoluted portion of the vas deferens; 8, vas deferens.

Fig. 155.—1, efferent canal, showing its comparatively large calibre and straight direction; 2, beginning convolutions; 3, cone formed by the convolutions, a conus vasculosus; 4, opening of the convoluted tube into the canal of the epididymis; 5, 5, the canal of the epididymis unravelled. (Sappey.)

vas. The pedunculated body called the hydatid of Morgagni, found between the upper portion of the testis and the globus major, is a remnant of the duct of Müller.

The continuation of the convoluted canal of the epididymis is known as the vas deferens; it ascends at the back of the testicle as part of the spermatic cord. Entering the abdomen through the internal abdominal ring, it descends to the pelvis, passing forward and inward across the external iliac vessels. On reaching the bladder it passes downward to the inner side of the ureter, and at its base is joined by a duct from the seminal vesicles to form the ejaculatory duct. The vas in the beginning of its course is convoluted, but for the greater part is uniformly cylindrical, and easily recognizable from the rest of the cord by its dense hard feeling; when it reaches the base of the bladder it becomes

markedly ampullated. It is provided with an external cellular coat, a muscular coat, and an inner mucous membrane, the latter covered with columnar epithelium.

The seminal vesicles are pouches placed between the bladder and the rectum. They are pyramidal in shape, with their bases directed backward, and, although they are of very variable size and shape in different individuals and often on the two sides, they average about two and a half inches in length and half an inch in breadth. They lie in direct contact with the base of the bladder, extending from the entrance of the ureter to the base of the prostate gland, and are separated from the rectum by the recto-vesical fascia. Each seminal vesicle consists of an irregular tortuous tube, sometimes giving off in its course several blind pouches, which are connected by fibrous tissue. At its lower extremity this tube becomes narrowed into a straight duct, which joins the vas deferens of the corresponding side, to form the ejaculatory duct.

The ejaculatory ducts are about three-quarters of an inch long. They pass forward and upward from the base of the prostate along the side of the prostatic sinus, and terminate in slits placed at the lateral margins of this sinus. The vesicles and ducts are provided with an external fibro-cellular, a middle muscular, and an internal mucous layer; the epithelium is columnar.

ANOMALIES OF THE TESTICLE.

- Anomalies of development.
  - In number.
    - Excess. — Polyorchism.
    - Deficiency.
      - Absence, anorchism.
      - Fusion, synorchism.
  - In size.
    - Excess. — Hypertrophy.
    - Deficiency. — Arrested development.
- Anomalies of migration or position.
  - Cryptorchidism (lying in some part of the normal course).
  - Ectopy (lying outside of the normal course)
  - Malposition in the scrotum.
    - Inversion.
    - Reversion.

(Modified from Monod and Terrillon.)

Anomalies of Number

1. Polyorchism.—With the exception of the case reported by Blasius, there seems to be no well-authenticated record of supernumerary testis. Cases are frequently encountered in which careful examination shows the existence of a body which in size, shape, and position corresponds closely to a third testicle; even the testicular sensation—*i.e.*, sickening pain on pressure—may be present. When opportunity has been given for complete examination, these apparently supernumerary testes have been proved to be encysted hydroceles, epiploceles, fibromata, or other comparatively common pathological conditions.

2. Anorchism.—This deformity may be unilateral (monorchism) or bilateral. It is usually unilateral, and the epididymis and scrotal portion of the vas are also absent on the affected side. The pelvic portion of the vas and the seminal vesicles are ordinarily present, though cases are recorded showing that even these portions of the genital tract may be wanting. The testicle may

be present, but the epididymis or vas or both these structures may be absent. Bilateral anorchism is accompanied by absence or incomplete development of the scrotum, a rudimentary condition of external genitalia, impotence, sterility, and the physical and mental attributes of eunuchism.

3. Synorchism, or fusion of the testicles, is an extremely rare condition. It seems to have been found only in fœtal life. The diagnosis of the condition is dependent upon the finding of two cords.

Diagnosis.—A distinction between bilateral retention and anorchism may be made by the rudimentary condition of the penis when the testicles are absent, and by the later development of eunuchism.

Treatment.—Unilateral anorchism gives rise to no symptoms, since one testis, if it remains healthy, is competent to perform the functions of both. Bilateral anorchism would seem to be beyond help except by the transplantation of testicular substance. One might thus so modify the course of development that, though potency and fertility cannot be expected, the physical and mental characteristics of the male may be preserved. While the removal of either testicles or ovaries in early life usually changes profoundly all the characteristics, physical and mental, of the individual, the testicles may lose or may never have had the sperm-producing power and still possess the quality which enables them to hold the organism in its normal groove and to invest it with the other attributes of masculinity. When testes fail to descend, as a rule they are incapable of producing spermatozoa. In spite of this imperfection of the organs, the external bodily characteristics of the male are acquired.

It is possible that the function of the testicles which relates to the preservation of masculinity, as distinguished from the function of reproduction, may be exerted through a definite substance which has distinct physiological properties of its own, manifest to some extent whenever it is introduced into the system. It therefore seems reasonable to hope that regularly repeated injections of testiculin may exert a powerful influence on the general development of bilateral anorchids. These injections should be instituted at an early age, certainly before puberty, and should be continued for many years. The dosage, the number of repetitions, and the period of time over which treatment should extend cannot be formulated.

Anomalies in Size

Hypertrophy.—In common with all the genital organs, the normal testicles vary greatly in size and without any definite relation to the general physical development or to functional activity. It is, therefore, difficult to determine what degree of growth indicates a departure from the normal. In cases where one testicle has been removed or has become atrophied, the remaining gland may show so marked an overgrowth as to be properly considered hypertrophied. This is particularly likely to occur when there is congenital atrophy or unilateral ectopy. The destruction of the testicle by inflammation, unless this occurs in early life, is not commonly followed by enlargement of the other gland.

Atrophy.—The wasting which follows acute or chronic inflammation cannot properly be considered a congenital malformation, even though this atrophic

process takes place in early infancy. True atrophy is nearly always observed in cases of non-descent and ectopy. Even when the position of the organ is perfect one or both testes may remain puerile. It is a matter of clinical observation that these puerile testes may attain full development as a result of physiological activity.

Treatment.—Hypertrophy calls for no treatment, since it is compensatory and is dependent upon increased physiological activity. It is probable that a gland thus enlarged is more vulnerable than one of normal size: hence it is desirable to support it by a suspensory bandage if the scrotum is relaxed, and to caution the patient as to the special danger incident to urethritis.

The treatment of imperfect development of the testes promises little. There is, however, sufficient clinical evidence to prove that persistent, long-continued treatment may be followed by gratifying results. Thyroid extract, pituitrin, and desiccated pineal gland would all seem indicated. The stimulating influence of massage regularly administered should be borne in mind, and the effect which physiological activity has upon growth and nutrition should be considered in advising such patients and in predicting as to their future.

The bringing down of an undescended testicle has been followed by rapid increase in size.

ANOMALIES IN MIGRATION

The testicle may be arrested in its transit from below the kidney to the bottom of the scrotum at any portion of its course. It may depart from its regular path, taking an aberrant course, or, having descended normally, it may assume a faulty position in the scrotum.

Arrest of Passage in the Normal Course

The testicle may be arrested in the abdominal cavity or in the inguinal canal, or may incompletely descend into the scrotum—the condition known as cryptorchidism.

Abdominal retention may be unilateral or bilateral. The testicle may be found close to the posterior abdominal wall in relation to the lower border of the kidney, it may be provided with a long mesorchium allowing it to move freely in the abdominal cavity, or it may lie in the iliac fossa close to the internal ring.

In inguinal retention the testicle may be arrested at the internal ring, in the inguinal canal, or at the external ring (Fig. 156), and until it becomes adherent by inflammation it is usually extremely mobile. This variety is most important because of its frequency, because from its exposed position the testicle is subject to irritation and injury, and, finally, because it is liable to be mistaken for hernia and usually has this as an associated condition.

In incomplete scrotal descent (cruro-scrotal retention) the testicle lies outside of the inguinal canal, but fails to descend completely, and is found in the fold between the scrotum and the thigh, at varying distances from the ring.

When the testicle takes an aberrant course (ectopy) it may be found beneath the skin of the abdominal wall at a variable distance from the external abdominal ring, in the crural region, or in the perineum.

In perineal ectopy the testicle is found as a distinct ovoid tumor, lying to

one side of the central raphe and in front of the anus. The cord can often be traced from this tumor to the external abdominal ring, and the overlying skin sometimes presents the peculiarities of the scrotum, the corresponding side of this sac being generally atrophied. A testis thus placed can scarcely escape frequent injury, with consequent inflammation and destruction of secreting structure.

In femoral ectopy the testicle occupies the position of a complete femoral hernia, though Curling notes a case in which the gland was three inches below Poupart's ligament and behind the femoral vein, with the cord encircling this vessel. The testicle passes beneath Poupart's ligament and through the saphenous opening.

Curling, after considering the etiology of nondescent, maintains that in some

FIG. 156.—Undescended testis: Note the inguinal swelling with corresponding atrophy of the scrotum. (Case of unilateral inguinal cryptorchism and phimosis.)

cases retention is due to the small size of the external ring. Other causes which may be operative are the application of a tight-fitting truss before the descent of the testis, shortness of the vessels of the cord, and a long mesorchium preventing the testicle from entering the canal.

The irregular development of the gubernaculum will explain crurofemoral and peno-pubic ectopy. The lower attachments of this fibro-muscular structure are Poupart's ligament in the course of the inguinal canal (Curling), the lower part of the scrotum, and the pubic bone. There are also fibres passing to the region of the saphenous opening. Relative over-development of certain of these bands may draw the testicle into a faulty position.

As a rule, misplaced testicles are undersized, though apparently healthy until they have been subjected to repeated attacks of inflammation. When

removed from the adult and examined they show degeneration and atrophy of the secreting structure. This, however, is inflammatory in nature and not inseparably connected with under-development. Curling holds that undescended testicles are functionless so far as reproduction is concerned, and hence that bilateral retention causes sterility, though not necessarily impotence.

Monod and Arthaud have attempted to demonstrate, on the other hand, that a retained testicle may secrete healthy semen and show no degenerative changes on section, such alterations being due to repeated inflammations to which the gland is necessarily subject from its faulty position. In one undescended testicle which we removed from a man forty-five years old in the course of a radical operation for strangulated hernia, microscopic section of the gland, which was about the size of that normally found in a child of twelve, showed it to be fully functional, although it had been subject to a number of inflammatory attacks.

Incomplete transit is most commonly manifested in the form of inguinal retention; the aberrant transit, in the form of perineal ectopy.

Complications of Misplaced Testicles.—Hernia, inflammation, and malignant degeneration are the serious complications of abnormally placed testes.

Hernia is an extremely common complication, and is of the congenital variety—*i.e.*, there is a direct communication from the abdominal cavity to the testis, the funicular portion of the peritoneal sac not having become obliterated. The funicular form is also found; in this the testicle is shut off, but the peritoneal pouch which descends with the cord still remains patulous. Hernia is a grave complication of misplaced testis, since it is especially liable to sudden and complete strangulation. Because of the presence of the testicle a retaining truss can rarely be worn.

Inflammation frequently attacks a misplaced testicle, particularly the inguinal form, since the imperfectly developed gland seems to be especially vulnerable. Inflammation may be due to traumatism or to extension of infection from the posterior urethra. Traumatic inflammation may be caused by a blow or by sudden contraction of the abdominal muscles, which pinch the testicle in its already too straitened environment. It is probable that the misplaced testicle is not immune against the infection which develops in the course of mumps, typhoid fever, and other diseases which are often complicated by orchitis. Jacobson states that syphilis and tuberculosis have not been observed to attack such testes.

Malignant Degeneration.—The comparative frequency with which malignant disease attacks misplaced testicles is generally recognized. The predisposition is probably due to the frequent inflammatory attacks to which the gland is subjected.

Symptoms.—Symptoms of anomalies of migration of the testis are wanting. Until the onset of complications there will be no complaint, except perhaps slight transitory testicular pain, caused by sudden violent muscular exertion or by blows or jars in the region of the misplaced gland. The complications are, however, extremely important, since some of them directly threaten life.

The symptoms of orchitis are practically the same whether the testis is descended or undescended.

Hydrocele and hæmatocele frequently complicate inflammation. Hydrocele may be of the congenital variety,—that is, reducible into the peritoneal cavity; sooner or later it becomes distinctly limited.

Exceptionally, the testicular inflammation may cause general peritonitis; Curling has reported one death from this complication. Very commonly abdominal symptoms develop so suddenly and violently that they closely simulate those dependent upon the presence of a strangulated hernia. There may be tympany, tenderness, constipation, and vomiting so persistent as to have a markedly stercoraceous character. The distinction between orchi-epididymitis attacking an undescended testicle and strangulated inguinal hernia is often extremely difficult to make.

Hernia when it complicates undescended testicle is manifested by the usual symptoms, but will often exhibit the peculiarity of not being amenable to treatment by truss, pressure of the pad producing so much pain that it cannot be borne. The hernia may pass beyond the testis, reaching the scrotum; sometimes it pushes the testis in front of it, thus curing the displacement. When the hernia becomes strangulated the symptoms are not different from those commonly observed in strangulated hernia.

Malignant degeneration exhibits the symptoms which characterize cancer of the normally placed testis, except the location of the tumor. The testicle steadily and rapidly enlarges, becomes irregular in shape, often cystic, painful, and involves the anatomically related glands. The skin is discolored and marked by large veins. In cases of abdominal retention the diagnosis cannot, of course, be formulated until the tumor has reached considerable size, since till then it is not palpable. A persistent, steadily increasing, obstinate pain should in the case of abdominal retention suggest the possibility of malignant infiltration. In the late course of malignant disease the diagnosis is made clear by the large palpable tumor and glandular involvement.

Diagnosis.—The diagnosis of misplaced testicle is based on (1) the absence of the gland from its normal position; in infants and young children the testes may be extremely small, sometimes not much larger than a kidney-bean, and because of their great mobility may be hard to find; (2) the detection in the abnormal position of a smooth, usually movable tumor, shaped like a normal testicle, but smaller, and yielding on pressure the testicular sensation; in making this examination, unless the testis is found, the patient should be instructed to cough and strain, since thus there may be brought within reach an undescended testis lying high up in the inguinal canal; (3) atrophy of the scrotum of the side corresponding to the misplacement (Fig. 192). In cases of abdominal retention the only signs are absence of the testis from the normal position and atrophy of the scrotum.

Prognosis.—The prognosis of imperfect descent of testicles is fairly good in young children, since ultimately the gland is likely to reach its proper position. This is not true of ectopy. In case the gland does not descend before birth, it commonly does so shortly afterwards, and no anxiety should be experienced for several weeks, especially if the testicles can be felt in the inguinal region

and the scrotum is properly developed. If the descent does not take place during infancy or childhood, there is still a chance that it may occur about the period of puberty, sometimes as the result of violent straining effort. The gradual descent is often complicated by hernia.

As a rule, a testicle which has shown no signs of descent by the sixth year will retain its faulty position unless subjected to surgical treatment.

Treatment.—Abdominal cryptorchidism is difficult to remedy—at times impossible—as the vascular and nervous attachments are very short, and

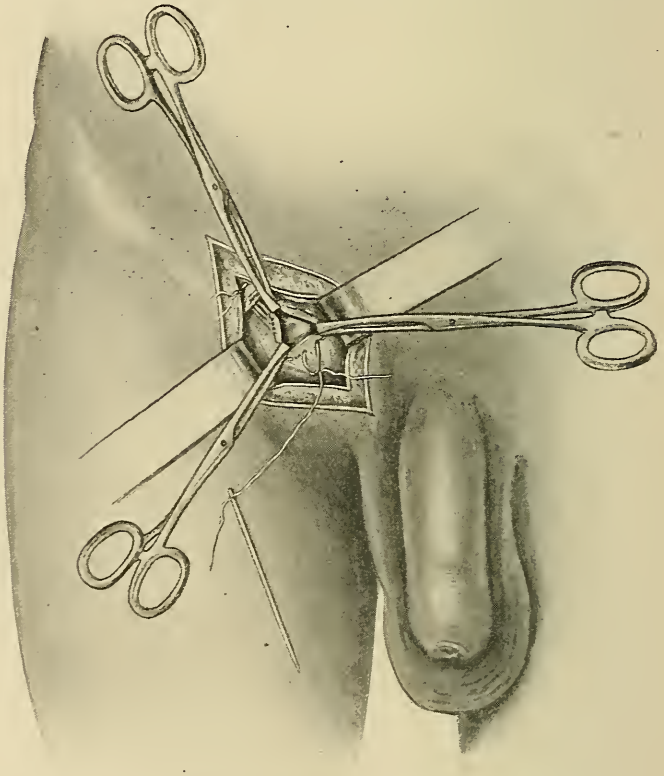


Fig. 157.—Second step in operation for undescended testicle. The vaginal tunic has been cut across above the testicle, and the upper extremity ligated. The distal end is being closed in order to form a closed tunica vaginalis for the testicle.

in some cases the gland cannot be located; nor in the absence of symptoms (strangulation, inflammation, neoplasm) should a proper placement be attempted. Guelliot, however, reports a most suggestive case. He operated for bilateral abdominal nondescent: one testis was secured in the scrotum; two years later this gland was well developed, and the boy, then eighteen years old, was normal in regard to his sexual functions. In the semen were found a few apparently normal spermatozoa. While it is probable that patients subject to bilateral abdominal retention of the testicle will be sterile, they are likely to

suffer from no inconvenience, since the gland is so placed as to be protected from injury.

Inguinal retention should be treated conservatively in early life, the gland being encouraged to descend to its normal position by gentle manipulation with the fingers. Persistence in this treatment is justifiable to the sixth or eighth year if the testicle in the meantime does not become inflamed or show signs of atrophy. After the sixth year the operative treatment may be considered, but it should be remembered that spontaneous descent may take place about the period of puberty; this is, however, not the rule. Operation is especially indicated if the malformation is bilateral, if the testicle has been subject to repeated attacks of inflammation, if a complicating hernia be present, or if from

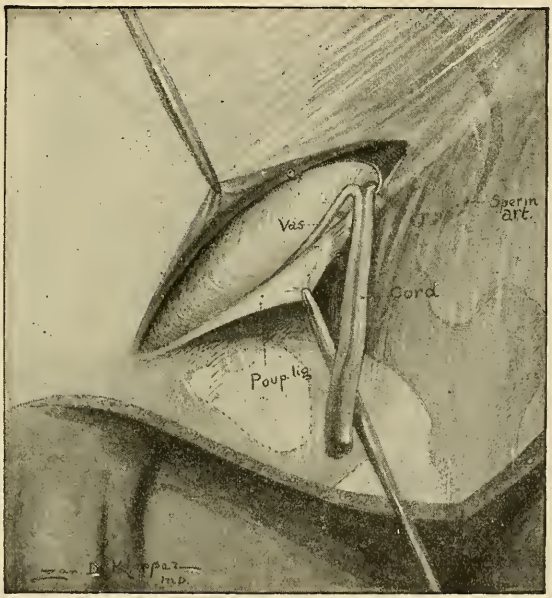


FIG. 158.—Showing floor of inguinal canal split from the internal inguinal ring to the pubis, dividing the deep epigastric vessels and exposing the vas deferens and in silhouette the spermatic vessels lying on the peritoneum before they join to form the spermatic cord. (From Surgery, Gynæcology, and Obstetrics, March, 1911.)

its position and its chronically inflamed condition it prevents proper indulgence in active sports.

Since one of the reasons for operating is to encourage growth, it should be undertaken before the most active period of development.

Operative Treatment.—An incision is made appropriate for inguinal hernia, and the testicle and cord are freed from adhesions. In practically all cases the tunica vaginalis is found to communicate with the abdominal cavity. This condition is treated by dividing the funicular process immediately above the testicle, ligating or suturing the distal portion so as to close the tunica vaginalis, and ligating the proximal portion at the internal ring (Fig. 157). The testicle is then drawn toward the scrotum so that the structures of the cord are put

on the stretch, and any adventitious bands and all cremasteric fibres are divided. At times this enables the operator to place the testicle in the bottom of the scrotum without tension. Usually further freeing is needful; this may be accomplished by either of two methods, those of Bevan and Davison.

Bevan's Method.—The structures of the cord are divided into two portions—the vas deferens and its vessels and nerves, in close contact with it and the pampiniform plexus; the latter may be sacrificed if needful. When, therefore, it is found necessary to lengthen the cord Bevan advises section of the spermatic vessels between ligatures.

Davison's Method.—Here advantage is taken of the fact that not only is there an angle in the course of the vas and its vessels, the turning inward at the internal ring, but also in the course of the spermatic vessels (Fig. 158). The bending here is outward, and lies just to the outer side of the internal ring.

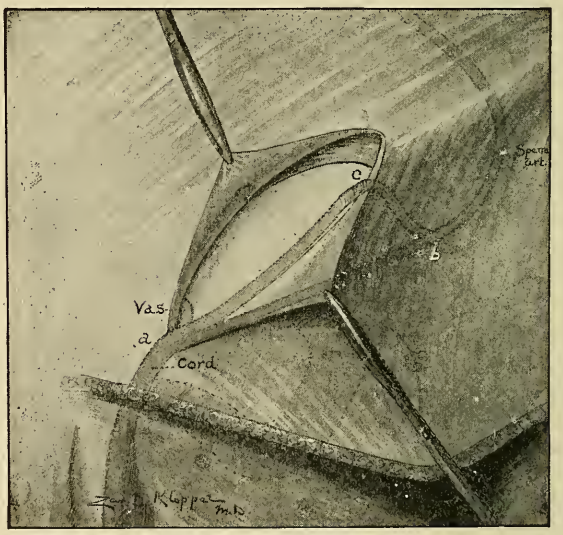


FIG. 159.—Diagram of the transplantation of vas deferens and spermatic vessels—lowering the cord, the difference between b. a. and b. c. a. (From Surgery, Gynæcology, and Obstetrics, March, 1911.)

The operation consists in moving the internal ring mesially till it lies behind the external ring (Fig. 159), and is accomplished by ligating the deep epigastric artery between ligatures, incising the posterior wall of the inguinal canal, formed by the transversalis fascia, so that the peritoneum is exposed, and then by blunt or gauze dissection freeing first the vas and its vessels and then the spermatic vessels, the cut edge of the transversalis fascia being drawn downward and outward to facilitate the latter procedure.

When a sufficient length of cord has been obtained, a bed for the testicle is made in the scrotum by blunt dissection with the fingers, and the testicle is placed and retained therein. This retention is not always an easy matter. Sometimes it may be accomplished by suturing the tissues about the cord at the upper part of the scrotum, by suturing the cord to the external ring, or by

suturing the testicle to the bottom of the scrotum, the suture being passed through the gubernaculum testis or the tunica propria of the testis and through scrotal skin, the knot being tied on the outside. Debule has suggested passing the testicle through an incision in the scrotum and suturing it temporarily to the deep fascia of the thigh, the skin of scrotum and thigh being also united by suture. Davison advocates bringing the ends of a suture of silkworm gut which has been passed through the gubernaculum testis through the bottom of the scrotum, and attaching them to a light rubber band, the other end of which is attached to a piece of adhesive plaster fastened about the thigh above the knee; in his case the thigh must be kept in extension by a plaster-of-Paris or other fixative dressing. In all cases careful suture should close the inguinal canal and reduce the opening through which the cord passes to its safe minimum.

Ectopy of the Testicle

Perineal ectopy should always be subjected to operation, since from its position the testicle is exposed to frequent injury. It is well to wait until the third or fourth year of life before attempting replacement, because after that time there is less danger of infection through soiling the dressings. This plan is advisable, provided the testis is not injured by the exercises of early childhood, such as walking, running, and playing. The wound can, however, be almost perfectly protected by the application of a collodion dressing.

The testicle is pushed as near the scrotum as possible, and an inch and a half incision is made on the scrotal side of the testis and at right angles to the raphe, exposing the cord; by drawing upon this structure and by the use of retractors the testicle can be exposed and the fibrous adhesions binding it to its faulty position divided. Through the cellular tissue a way is then made to the bottom of the scrotum; this pouch is invaginated into the wound, the base of the testis and the epididymis are secured to it by two or three sutures, and the perineal wound is sutured at right angles to its length, thus deepening the scrotal pouch.

Pubic and crural ectopy are so rarely found that their treatment by operative procedures has not been formulated. A testicle placed in front of the pubis at the root of the penis may be transplanted into the scrotum without difficulty.

In crural ectopy the testis should be reduced into the abdominal cavity, together with the hernia which usually accompanies it, and should be retained by suture. Failing this, a protecting truss may be applied. If the testis is still subject to attacks of inflammation, castration is generally advised, though from the surgical point of view there seems no good reason why the testis could not be placed in its proper position by freeing it and its cord and dividing Poupart's ligament.

Treatment of Complications of Misplaced Testicle.—Inflammation.—The general indications in the treatment of inflammation of an undescended or ectopic testis are those appropriate to a like condition of the normally placed gland. Rest in bed, elevation of the pelvis, moderate purgation, the application of heat or cold, depending upon the preference of the patient, and the relief of pain by hypodermic injections, represent the general line of treatment. When the inflammation ranges high and there is doubt in regard to diagnosis, there

should be no hesitation in making an incision and exposing the gland, since the relief of tension thus secured is immediately followed by marked alleviation of pain.

Hernia.—When cryptorchidism is complicated by hernia, and the latter exhibits a tendency to push the misplaced testis before it, thus favoring its descent, no retention apparatus should be applied until the gland has escaped from the external ring. A truss should then be so adjusted that it will keep the hernia from descending and push the testis still farther down. Cases are rare in which the hernia exhibits this tendency. More frequently it slips beyond the testicle, escaping through the external abdominal ring before the gland; a truss is then insupportable, and operation offers the only prospect of cure. If the patient is young and the testicle has not been repeatedly inflamed, the gland is brought to its normal position in the scrotum and the hernia is radically cured. If there have been repeated attacks of inflammation it is usually desirable to remove the testicle, entirely closing the rings and canal.

Malignant growth should be treated by early and complete removal. When the testicle is intra-abdominal this form of intervention is rarely practicable until the disease has become so well developed that there is no prospect of radical cure, since diagnosis cannot be made until a decided tumor develops. In inguinal ectopy enlargement of the gland may be detected early. Therefore operative interference promises better results. Whenever an undescended testicle increases in size without inflammatory phenomena, operation should be performed immediately. The removal of malignant testicle is usually unattended with operative difficulty.

Torsion.—The undescended testicle seems to be particularly subject to the accident of strangulation by torsion. When symptoms of extremely severe inflammation develop with unusual suddenness and severity and without obviously sufficient cause, incision and exposure of the undescended testis are indicated. The cord may be untwisted or the testis removed. The latter course is desirable, when but one organ is affected, since testes subject to torsion are liable to undergo malignant degeneration.

Inversion of the Testicle

The testicle, though it descend to the bottom of the scrotum, may assume various faulty positions termed inversions. This displacement may be anterior, horizontal, or lateral. The anterior form is commonest, the testicle being rotated completely, the epididymis lying in front, the free border to the rear.

No treatment is indicated in these cases, displacement being important mainly when surgical intervention is required,—for the cure of hydrocele, for instance. With this present in the case of anterior inversion, the testicle and epididymis would lie in front and not behind the fluid contained in the sac of the vaginal tunic; hence were a trocar introduced at the customary point it would wound both the testicle and epididymis. The possibility of inversion is a reason for invariably examining hydrocele by transmitted light before tapping. When the sac-wall is thick or the contents are turbid careful palpation will usually elicit the testicular sensation, suggesting the faulty position of

the gland. Monod and Terrillon advise that in tapping cases where the position of the testicle remains in doubt, the puncture should be made on the outer side of the scrotum instead of in front.

Of the other forms of inversion fewer cases have been reported, nor are they of great surgical importance. In the horizontal variety the long axis of the gland lies in the horizontal position, the epididymis looking upward. Lateral inversion is a modification of the anterior variety. Reversion of the testis has been reported by a few observers; the upper end of the gland looks downward. We have seen one such case.

Luxation of the Testicle

The testicles may be displaced by direct traumatism or muscular action. The ordinary cause of this displacement is sudden violent contraction of the cremaster muscle reflexly excited in the course of a severe general muscular strain. The testis may be fixed in the groin external to the ring from tonic spasm of the cremaster, may be lodged in the inguinal canal, or may be drawn even within the abdominal cavity; it is generally found within the inguinal canal. It shortly becomes inflamed and is subject to the general accidents already considered under the head of congenital displacement.

Treatment.—The treatment of luxated testicle is prompt replacement. This usually requires the administration of ether, since inflammation develops rapidly and the gland becomes excessively tender. If the testicle is held in its faulty position by adhesions or tonic contraction of the cremaster muscle, the operation for incomplete descent is indicated.

Torsion of the Testicle

Torsion or axial rotation of the spermatic cord sufficiently describes the nature of this accident. It is one of sudden development, usually affecting the cords of undescended testes, though by no means confined to these. The cause of this twist has not been formulated; it is probably dependent upon congenital malformation, since Owen has pointed out that a testis properly placed in the scrotum and possessed of a normal mesorchium cannot be twisted. The twist may be either to the right or to the left, and in accordance with its extent and the degree of constriction to which the vessels are subject the symptoms are slight or severe. In slight cases the epididymis alone becomes infiltrated. In severe cases the entire gland with the epididymis becomes gangrenous, exhibiting extensive blood extravasations.

Symptoms.—The symptoms of torsion are those of epididymitis or orchi-epididymitis. They occur suddenly, often without apparent cause, during active muscular exertion. When the rotation is sufficient to produce complete strangulation the symptoms are violent and rapidly progressive. In cases of abdominal or inguinal retention these symptoms may be augmented by those of a local peritonitis. The lesion has occurred in infants.

Diagnosis.—A positive diagnosis is rarely possible without direct exploration through an incision, the symptoms suggesting an excessively acute orchi-epididymitis or a strangulated hernia. Since torsion commonly affects an undescended testis—so often complicated by hernia—the differential diagnosis may be extremely difficult. The inguinal tumor is painful, swollen, sometimes

reddened and œdematous, and gives no impulse on coughing; it develops quite suddenly after exertion. Vomiting and tympany are by no means uncommon. These symptoms are so like those of strangulation—indeed, are so indistinguishable from this condition—that immediate exploratory operation is indicated.

When the testis occupies a normal position there is little likelihood of confounding a twist of the cord with hernia unless the latter has been a previous complication, since the cord can be felt above the swelling and the inguinal canal is free from hernial sac or contents.

The diagnosis of torsion will, then, depend mainly upon the suddenness of onset, the severity of symptoms, and the absence of other sufficient causes for acute inflammation. Moreover, the epididymis may be felt in front of the testis, and a nodulation corresponding to the twist may be distinguishable.

Prognosis.—If untreated, the testicle will either atrophy or become gangrenous; gangrene probably depends upon hæmatogenous infection of the devitalized area.

Treatment.—Reduction should be effected by manipulation or by operation. Rotation must be made in the direction opposite to that which is causative of pain.

When the patient is not seen early, and when the inflammatory phenomena are pronounced, incision is indicated. This should expose the testicle and cord. If the gland is black and gangrenous it should be removed. Otherwise the cord should be untwisted, one lateral surface of the testicle secured to the scrotum by several sutures, including the proper tunic of the gland and the deeper layers of the skin, and the wound closed. When the testicle is greatly swollen and discolored, even though it is not absolutely certain that gangrene has taken place, it is advisable to remove it if the testis on the other side is healthy.

CONTUSIONS AND WOUNDS OF THE TESTICLE

Contusion.—The testicles from their position and mobility usually escape the effects of sudden direct pressure applied to the region of the perineum and scrotum. They may, however, be pinched against the pubis or perineum or be bruised by a blow or a squeeze. The lightest form of contusion—such as that sometimes experienced in crossing the legs or riding the bicycle—is attended by momentary sickening pain, with a slight sense of soreness, which may last a few minutes or even a day or two, and probably is not attended by distinct lesion, except in those who previously have been subject to latent disease, such as tuberculosis or tumor.

Monod and Terrillon, on the basis of an experimental investigation, classify testicular contusions as of three degrees: the first is characterized by minute disseminated capillary hemorrhages into the connective tissue lying between the seminal tubules and the convolutions of the epididymis. There is often epithelial exfoliation from the inner surface of the epididymis. Larger blood effusions characterize the second degree, and there is laceration of the tubules; the extravasations may vary from the size of a pea to that of a cherry. The third degree of contusion is characterized by rupture of the tunica albuginea. The gland is practically crushed, and there is bleeding into the vaginal tunic, with the formation of acute hæmatocele.

Symptoms.—These vary in accordance with the extent of injury. Slight contusions are characterized by a feeling of faintness, intense sickening pain, retraction of the testicle, and rather rapid swelling. When the contusion is severe there may be profound shock or almost instant death.

The first exhausting, almost unbearable anguish is of comparatively brief duration. There follows a severe, unremitting ache, aggravated by standing, coughing, or straining. This persists until reactionary phenomena have reached their height, and is so harassing that anodynes are required for its relief. The swelling, which becomes perceptible within a very few minutes and develops rapidly, is due in part to effusion of blood and serum into the vaginal tunic, in part to œdema of the loose cellular tissue of the scrotum. Profound discoloration is common, and is caused by rupture of the vessels of the scrotum; exceptionally it is due to bleeding from the testis and epididymis or cord. The inflammation usually remains aseptic, reaches its height in from five to eight days, and subsides slowly. Exceptionally suppuration occurs. In this case, in place of subsiding, the symptoms increase in severity, the patient suffers from chill and fever, redness and œdema become especially well marked, and finally fluctuation is detected.

Prognosis.—In slight contusions, characterized by transitory pain and disability, lasting at most a few hours, the prognosis is favorable. In the severer form of contusion (*i.e.*, those putting a patient to bed for one or two weeks) an opinion as to the future integrity of the testicle should not be expressed too confidently. In a certain number of such cases atrophy develops, apparently uninfluenced by treatment. Atrophy may follow even slight bruises, and is most apt to occur during youth; the epididymis is usually spared. In the severest forms of contusion, characterized by rupture of the albuginea, atrophy is certain to result.

The atrophic processes may be progressive and uninterrupted, the testicle regaining its normal size on disappearance of the inflammatory swelling, and then continuing slowly to shrink, or the acute inflammation may be succeeded by a condition of chronic irritation, characterized by enlargement and tenderness and occasional attacks of pain. This chronic pain and swelling gradually subside, intercurrent subacute attacks becoming less pronounced, the testicle ultimately becoming wasted. This wasting may affect only a portion of the gland, producing asymmetry; but usually the whole organ is affected, there remaining when the process is completed a body of varying shape, about the size of a Lima bean or even smaller than this.

Malignant disease frequently follows severe testicular trauma.

Prognosis is then always guarded, and becomes less favorable in proportion to the severity and the persistence of inflammation.

Treatment.—Even the mildest forms of contusion of the testicle should not be neglected, since exceptionally they are followed by chronic inflammation and atrophy. In severe injuries, shock and syncope are treated in accordance with general principles, and the agonizing pain is controlled by the injection of morphine. The patient should be placed upon his back, with the pelvis elevated and the scrotum supported either by a pillow placed against the perineum; or by a triangular handkerchief bandage, the base of which is passed

beneath the scrotum, while its ends are secured to a band about the waist; or by a bridge of adhesive plaster stretched from thigh to thigh. To the injured testicle cloths kept constantly wet in lead water and alcohol are applied, omitting oiled silk, since this prevents the cooling effect of evaporation. A small ice-bag is even more efficient, and can be used for three or four days, a piece of lint being kept between its surface and the skin of the scrotum. If cold makes the pain more severe, hot compresses wrung out of dilute lead water and renewed every fifteen minutes may be employed, or lint soaked in this same lotion may be applied, and over it may be placed a hot-water bag. The bowels should be opened freely.

When the swelling is so rapid and extensive as to threaten the vitality of the parts there should be no hesitation in cutting down upon and securing the bleeding points. Discoloration incident to scrotal blood effusion should not be mistaken for gangrene. The patient should be kept confined to bed until the active inflammatory symptoms have subsided, and may then be allowed to get up, wearing the pressure suspensory bandage described in the section on the treatment of epididymitis. This bandage should be worn for months, and the patient should be cautioned against occupations or exercises liable to cause a recurrence of inflammation, such as those requiring long standing or much straining. Small doses of potassium iodide and application of mild counter-irritants to the skin of the scrotum are serviceable in relieving the chronic congestion which is liable to follow upon injury of the testis, and which is certain to result in deposition of fibrous tissue and subsequent wasting of secreting structure.

Epididymo-orchitis from Strain.—This inflammation is properly considered under the head of contusion, since in a certain proportion of cases the symptoms are due to pinching or bruising of the testicle.

There develops, without a preceding urethritis and without obvious cause, a swelling which closely resembles in symptomatology and course either epididymitis secondary to gonorrhœa or traumatic epididymo-orchitis.

Terrillon records the case of a man who, in making a violent lifting effort, experienced a sudden pain in the left testicle so acute that he fainted. There was no contusion, no blood effusion. The testis was fixed in the left groin, and exhibited the tenderness, swelling, and pain of acute orchitis. Symptoms simulating localized peritonitis supervened, and lasted for eight days. The patient was confined to bed for three weeks. At the end of that time the testicle had atrophied until it was one-fifth its natural size; it was so tender that palpation could not be endured. The thigh was flexed, adducted, and rotated inward. As two months' further rest did not relieve the symptoms, castration was performed.

From careful observation of more than a dozen of these cases we believe that etiologically they can be classified as follows: 1. Epididymo-orchitis due to a violent contraction of the cremaster muscle, which by suddenly jerking the testicle against the pillars of the external ring causes a bruising of the former, often accompanied by rupture of the veins; this is called " whip-snap " action. When the external ring is patulous the testicle may be drawn within its grip and may be further bruised in this way. 2. Epididymo-orchitis from

rupture of the veins. As a result of violent muscular effort and increased intra-abdominal pressure the often-dilated, valveless veins of the cord become enormously congested. This congestion is further increased by compression on the part of fibres which Roux states pass from the rectus muscle to the inner lip of the iliac crest. These fibres participating in the general muscular contraction pinch the cord against the fibrous circumference of the external abdominal ring. Rupture of vessels and bleeding into the cord, the epididymis, or possibly the substance of the testis result. 3. Epididymo-orchitis from masked lesion. In a certain number of cases we have been able to trace the inflammation to infection passing from the posterior urethra along the vas; strain and possible slight contusion were undoubtedly favoring factors. The symptomatology and course of the inflammation were not different from those commonly observed in cases of chronic posterior urethritis. Twice we have observed acute tuberculous epididymitis develop suddenly after muscular effort.

In accordance with the cause of the inflammation, variations in its clinical course are observed. There may be an acute epididymo-orchitis, such as that which follows ordinary traumatism, temporarily prostrating the patient and keeping him in bed for days or weeks. The inflammation may be limited almost entirely to the epididymis and may run its course in a few days. Or there may be an almost painless enlargement, neither confining the patient to bed nor interfering with his occupation, provided a suspensory bandage is worn.

The left testicle is more frequently involved than the right; this is what would naturally be expected if the theory of venous rupture from pressure be correct.

Prognosis.—The prognosis of epididymo-orchitis from strain is much better than when external violence is the cause. When the lesion is simply hemorrhagic, the blood being found in the lower part of the cord and about the epididymis, with but slight congestion of the testicle, atrophy of this organ is not to be feared. When the inflammatory attack is limited chiefly to the testis and is severe, there is wasting.

Treatment.—The treatment is that appropriate to contusion of the testicle. Even in the comparatively painless cases a properly fitted pressure suspensory bandage should be worn for a long period.

Wounds of the Testicle.—**Incised wounds** of the testicle if kept clean heal promptly. Such injuries are extremely rare, except in the course of surgical operations, particularly those undertaken for the purpose of establishing diagnosis. If the proper tunic is opened and the testis found healthy, the albuginea should be neatly apposed with catgut sutures and the external wound closed. Infection may be followed by prolapse of the secreting substance of the gland unless drainage is promptly established. In tuberculous or syphilitic cases the so-called benign fungus may follow incised wounds.

Punctured wounds are usually inflicted by a misdirected trocar. Provided the instrument is clean, they are harmless. If a dirty instrument infects the testicle, diffuse acute orchitis may develop, with total destruction of the secreting substance.

Lacerated and gunshot wounds should be treated by thorough cleansing and abundant drainage. When it is evident that the testicle is extensively

bruised, castration is the best treatment. When both testicles are involved in gunshot wounds every effort should be made to preserve even small portions of the secreting substances of the glands. This is usually practicable if the wound is kept clean. If suppuration takes place, complete atrophy will probably be the result.

Otis states that atrophy and neuralgia are common sequelæ of gunshot wounds of the testes when castration has not been performed.

On the first sign of infection after an attempt has been made to close a wound of the testicle, the stitches should be removed, the wound widely opened, and drainage secured by a gauze wick.

After cleansing and closure of a wounded testis and the application of a proper dressing, the part should be elevated, and should be subjected to moderate pressure by means of a crossed-of-the-perineum bandage. Outside the antiseptic dressing applied immediately over the wound is placed a sufficient quantity of cotton or crumped gauze to equalize the pressure of the bandage. The bandage should be seven yards long and three or four inches wide. It is fixed by a circular turn about the pelvis, placed beneath the iliac crest. It is then carried downward along the right groin, across the perineum, around the back of the left thigh at the position of the iliofemoral fold, upward over the trochanter and below the crest of the ilium, completely around the body until it is just above the left trochanter, down along the left groin, across the perineum, around the back of the right thigh at the iliofemoral fold, and upward and forward over the right trochanter. These turns are repeated, alternating occasionally with circular turns about the pelvis, until a firm dressing is formed which entirely covers in the scrotum and perineum.

INFECTIONS OF THE TESTICLE

Infection of the testicle may be acute or chronic. The acute infections are secondary to posterior urethral infections, usually gonococcic, or develop as complications or sequelæ of a general infection, such as mumps, typhoid, grip, malaria, or exanthemata. There is also a gouty orchitis. The chronic infections are usually tuberculous or syphilitic.

URETHRAL EPIDIDYMITIS

Gonorrhœal urethritis is the commonest cause of epididymitis, the inflammation being almost entirely confined to the epididymis. The vaginal tunic is commonly inflamed, as is shown by the development of acute hydrocele, which may greatly increase the bulk of the swelling.

Epididymitis is a common sequel of instrumental urethritis—for instance, that following the use of the lithotrite, or frequent catheterization. It sometimes complicates gouty urethritis.

It is an expression of infection carried by the vas, and may therefore complicate any form of urethritis.

Symptoms.—The first suggestion of trouble may be felt in the groin or in the epididymis itself. In the former case an aching, sometimes a neuralgic, pain is felt along the line of the groin. often running down to the testicle, and made much worse by standing or walking. If the cord be taken between the thumb

and finger and rolled so that its constituents are separated, the vas deferens may be found somewhat enlarged and tender on pressure. Sometimes there is neither tenderness nor enlargement of the cord to be detected. If the inflammation progresses, the epididymis becomes involved in one or two days at most.

Frequently the disease develops without any previous manifestations of involvement of the cord. Suddenly there will then be felt in the testicle a fixed, dragging pain. The epididymis increases rapidly in size, the scrotal covering of the affected testicle becomes œdematous and purplish in color, and pain is at times almost unbearable and of a peculiar sickening quality which renders it diagnostic. If there be an anterior urethral discharge this is generally lessened; sometimes it entirely ceases for the time.

On palpation the epididymis is found to be sensitive and so much enlarged that it envelops the testicle above, behind, and below in a swelling more voluminous than the gland itself (Fig. 160). In the great majority of cases the inflammation extends to the tunica vaginalis and occasions an effusion of fluid, giving rise to an acute hydrocele; the latter entirely masks the testicles so that on palpation a fluctuating tumor is felt in front, which is often incorrectly diagnosed as a swollen testicle, whilst behind is the enlarged, exquisitely tender epididymis.

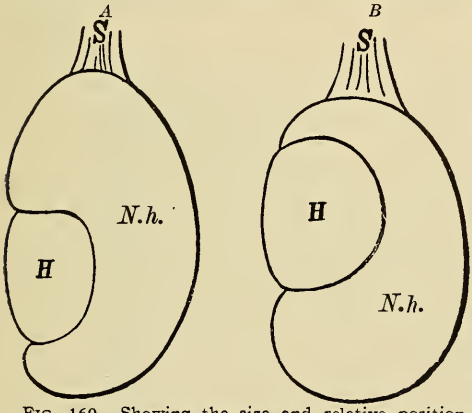


FIG. 160.—Showing the size and relative position of the testicle and epididymis in acute epididymitis. *H*, testis; *N.h.*, epididymis; *S*, cord. A, the swelling is most marked about the head of the epididymis. B, the swelling is most marked about the tail. (Kaufmann.)

The patient, unless the testicle is supported, walks with his body bent forward and his legs straddling. When he stands, free return of blood is prevented by the dragging of the tumor upon the spermatic vessels; this increases the tension and by additional pressure upon the nerves greatly aggravates the pain which sometimes spreads reflexly to the bladder, perineum, rectum, back, abdomen, thighs, and even to the thoracic region, and is almost unbearable.

There are usually rigors, fever, and great mental anxiety and depression.

Sometimes acute epididymitis in its onset is characterized by symptoms so violent and apparently so disconnected from the testicle as to occasion a mistaken diagnosis. In these cases there will develop, often in connection with a posterior urethritis fanned to new intensity, violent abdominal pains, accompanied by tympany and extreme sensitiveness in the lower part of the belly; fever runs high, and nausea, green vomiting, and collapse may follow. These symptoms subside almost as quickly as they develop, and are followed by the ordinary symptoms of epididymitis. The disease usually reaches its height in three to five days.

The clinical course of epididymitis varies greatly in individual cases. Some patients experience only moderate dragging pain, which does not incapacitate

them, and exhibit a somewhat sharply circumscribed tumor in the tail of the epididymis, with possibly slight hydrocele (Fig. 161), and a little reddening and induration of the scrotal skin overlying the seat of hardening. In the majority of cases the pain, though severe, is relieved by a properly fitting suspensory bandage, and the patient is not forced to take to his bed. The swelling is, however, usually very marked. Redness and œdema of the posterior aspect of the scrotum may be present; hydrocele when present may be general or may be encysted from inflammatory adhesions. On rectal examination a thickened tender mass corresponding in position with the ampulla of the vas and the seminal vesicle can usually be felt. When the funicular portion of the tunica vaginalis has not been obliterated there may be formed a true hydrocele of the cord.

Finally there are cases which, though not exhibiting especially severe local symptoms, are characterized by reflexes which so strongly suggest general peritonitis that they usually occasion grave anxiety unless a rectal examination be made. Exceptionally, when the testicle and its epididymis are not normally

Fig. 161.—Epididymitis, right side.

placed, an acute epididymitis may lead to an error in diagnosis. Thus, when the testicle is retained within the inguinal canal the early symptoms may readily simulate those of a strangulated hernia. An examination of the scrotum, by showing the absence of the testicle from its normal position, would at once suggest the diagnosis.

The pathological changes incident to epididymitis consist of a catarrhal inflammation of the vas and epididymis, associated in severe cases with œdema and round-cell infiltration of its walls and the surrounding loose connective tissue. Multiple foci of gonococcus-containing pus are present in the more serious cases, more often in the tail than in the head of the epididymis. The serous surface of the organ may be covered with a diphtheroid membrane.

Prognosis.—The prognosis of epididymitis is good, although cases are reported in which life has been lost from extension of the inflammation to the

peritoneum. These are extremely rare. The disease may undergo complete resolution; exceptionally suppuration occurs. Commonly the inflammatory infiltrate, instead of being completely absorbed, organizes in part, and forms a hard nodule in the tail of the epididymis which obliterates the efferent duct of the testicle. Exceptionally there is a permanent thickening of the entire epididymis. The hydrocele may become chronic.

Suppuration is denoted by increased severity of the local inflammatory symptoms, by rigors and sweats, and finally by fluctuation. On opening the abscess, prolapse of the entire epididymis sometimes occurs; when the suppurative inflammation has involved the testicle proper, this may be entirely destroyed in a short time by rapid extension of the trouble; or the suppurative process may become chronic and slowly extend, finally resulting in destruction of the gland. In pure gonococcic infection the testis is rarely involved in epididymitis, and hence is not materially altered even though its efferent duct is entirely blocked. Very rarely after the cure of a specially severe epididymitis the testicle slowly atrophies. In this event it is probable that the inflammation had extended to its structure, and as the infiltrate became organized and exercised pressure the glandular substance atrophied and was absorbed. Even though the inflammation undergoes apparent resolution it may favor the development of latent tuberculosis.

The prognosis in regard to fertility is, of course, good when but one testicle is affected, though even then it has been noted that spermatozoa disappear entirely from the semen during the height of an attack. When the epididymitis is bilateral the prognosis must be more guarded, though many of these cases recover with functionating testicles. In a certain proportion, however, especially in those not carefully treated, the epididymis of both sides becomes obliterated and the patients remain sterile. When the sterility is of long standing it can be helped only by operation. (See "Sterility.") Impotence is never a direct consequence of epididymitis.

Pure gonorrhœal epididymitis is much less likely to suppurate than that which results from instrumental infection. Suppuration is comparatively common in instrumental epididymitis.

The hard nodule left in the globus minor after gonorrhœal epididymitis usually persists indefinitely, nor is this persistence always proportionate to the original attack. Except during or shortly after an acute inflammatory period, treatment of these fibrous nodules is futile. The nodulation probably renders the individual sterile so far as that single gland is concerned, but it does not usually attract his attention or arouse his anxiety, and is therefore not the cause of hypochondriasis or neurasthenia, as otherwise it would be in the greater number of cases. With the exception of the testes, all glands atrophy when their ducts are completely obstructed. Adult testes with vasa congenitally absent form apparently normal and freely motile spermatozoa. Nor does sudden occlusion of the vas at any time of life affect the nutrition or function of the gland.

Treatment.—*Prophylaxis* consists in the wise treatment of the posterior urethral infection, and, until it is cured, the avoidance of intercourse, constipation, food surfeit, surface chilling, muscular strain, or excesses of any kind. The

wearing of a suspensory bandage is advisable. The passage of instruments through the posterior urethra should be accomplished with the greatest possible gentleness; the administration of full doses of atropine before such instrumentation is said to reduce the liability to this complication. On the first prodromal symptoms the patient should be put to bed, the bowels should be freely opened, preferably by a saline, the testicles should be wrapped in lead water and dilute alcohol, and elevated, and hot compresses and a hot-water bag should be applied to the inguinal region. These measures will usually limit the inflammation to a funiculitis, especially when the treatment appropriate to a posterior urethritis has been prescribed.

The treatment of gonococcal epididymitis may be either nonoperative or operative; the former may be further subdivided according to whether or not the patient is confined to bed. The great majority of cases can be treated in an ambulatory manner, though undoubtedly the attack is shortened by rest in bed; sociological considerations must often determine the method to be used rather than the best interests of the patient. Operative treatment most promptly relieves pain, and is followed by prompt subsidence of the inflammation. But by division of the duct of the epididymis the method is apt to sterilize the patient, so far as the affected side is concerned. For this reason it should only be advised in cases of the more severe grades, when rest in bed for two or three days has failed to check the inflammation, or where there seems to be danger of destruction of the testicle through abscess formation.

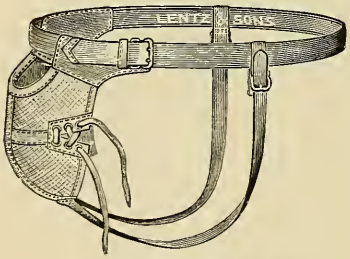


Fig. 162.—Epididymitis suspensory bandage.

Ambulatory Treatment.—The first essential of this form of treatment is the application of a suspensory of appropriate design. The bandage employed is a modification of the Langlebert-Horand, and brings to the relief of inflammation the most potent remedies at the command of the surgeon; namely, heat, moisture, rest, and pressure (Fig. 162). The body of the suspensory is made up of mackintosh, which is, in turn, lined with stout cloth. The bag of the bandage is shallow, and at the sides are gores which are provided with eyelets and laces. When a bandage of proper size is applied and strapped tightly it not only presses the testicles upward against the soft parts lying anterior to and below the pubes, but by the lacings also exerts lateral pressure, so that these glands are everywhere evenly supported. The method of applying this bandage is as follows: The patient is placed in a recumbent position, and the testicles and scrotum are held up for four or five minutes, thus reducing congestion as much as possible by position. The whole scrotum is then enveloped in a thick sheet of absorbent cotton or wool. Outside of this the suspensory bandage is applied. It is strapped on tightly, and is then laced at the sides. When the appliance is properly fitted, relief of pain is almost immediate and is usually permanent, and resolution takes place promptly.

An ointment may be used in addition to the suspensory with considerable advantage. The most valuable substance for such application is guaiacol, from

10 to 25 per cent. of which may be used. Its penetrating odor makes it objectionable to many, however, and may render its use undesirable. Ichthyol ointment, 5 per cent., or an ointment containing ichthyol, belladonna, and mercury, may then be employed.

When the acute inflammatory symptoms have subsided—*i.e.*, when the pain has lessened and is severe only upon motion, and the epididymis and the surrounding cellular tissue form a large solid mass—pressure is always indicated, whatever has been the previous method of treatment. This may be applied by means of a suspensory bandage, as already described, or through the medium of a strip of thin rubber dam eight to ten inches long and half as wide. The testicle is tightly encircled in this bandage, the final turn of which is secured by a strip of adhesive plaster. The dressing is most easily applied by fastening the upper margin of the bandage with adhesive plaster, before its application, at such a point that slight pressure is made on the cord, so that obstruction hyperæmia shall exist in the parts covered by the rubber. The dressing is then applied by stretching the rubber sufficiently to let it slip over the testicle. The lower portion of the dam is then laid smoothly over the swollen organ, and secured below with a second piece of adhesive plaster. A suspensory then completes the dressing.

When all inflammatory swelling has disappeared, but an indurated nodule persists, the pressure suspensory bandage should still be employed in conjunction with an ointment made of belladonna ointment and mercuric ointment equal parts, while internally five grains of potassium iodide should be given three times a day.

"Bed" treatment is required by the more severe type of the disease, both on account of the constitutional reaction and on account of the local pain. The diet should be restricted, and the bowels moved two or three times a day. If rest and sleep are prevented by the pain, morphine should be given in sufficient quantity to secure reasonable comfort.

The scrotum with the inflamed testicle should be elevated by means of a pillow, handkerchief bandage, or adhesive plaster support (Fig. 163), and swathed in gauze kept wet with a saturated solution of magnesium sulphate, or with the following solution:

℞ Tinct. aconiti, ℥i
Alcohol,
Liq. plumbi subacetatis, dil.,
Aquæ, āā f℥ ii.
M. S.—For external use.

In some cases guaiacol ointment seems to act better than either of these lotions.

Operative Treatment.—Under this heading are grouped tapping of symptomatic hydroceles, puncture of the epididymis, and epididymotomy.

Tapping of Hydrocele.—This procedure is so simple that it might properly be considered under one of the previous captions. It is performed by the insertion of a hollow needle, 16 to 22 gauge, through a puncture wound in the skin, and is indicated whenever a recognizable quantity of fluid is present. The amount of relief derived from this simple procedure is sometimes very great.

Puncture of the Epididymis.—Much benefit sometimes follows the simple insertion of a cataract knife or Hagedorn needle into the region of greatest infiltraiton, usually at the back of the scrotum and at about the middle of the epididymis. The puncture should be preceded by an injection of eucaine solution. A few drops of serum usually escape after the knife is withdrawn, and there is almost immediate lessening of pain. The operation need not confine the patient to his bed.

Epididymotomy.—This operation, popularized by Hagner, is best performed under a general anæsthetic (preferably nitrous oxide), though when due care is taken to block the nerves to the testicle by infiltration of the cord local anæsthesia may be used with satisfaction.

The operation is performed by making a sufficiently long incision on the outer side of the scrotum for the delivery of the testicle, the tunica vaginalis being

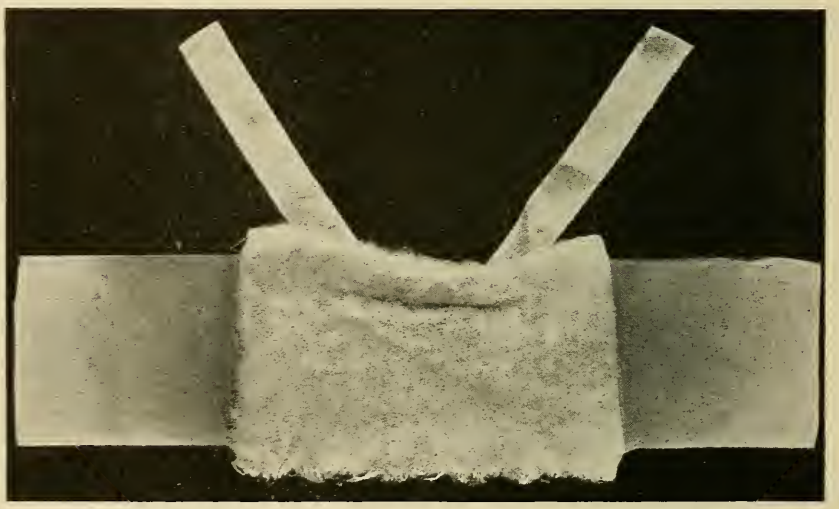


FIG. 163.—Adhesive strip for the support of scrotum. Narrow strips of adhesive plaster run up on the abdomen on each side of the scrotum to keep the broad strip in place; lint has been applied to the portion not adhering to the thighs (under surface shown).

opened freely. After delivery the epididymis is inspected and palpated to determine the points of greatest induration. These are generally found in the tail of the organ. A cataract knife is used to puncture the areas selected, the tracts made with the knife being enlarged with a probe should pus escape. The injection of solutions of argyrol (20 per cent.) or protargol (2 to 5 per cent.) into these tracts has seemed to be of advantage in some cases. The operation is concluded by the return of the testicle to the scrotum and the suture of the wound about a drain of rubber dam, down to the puncture points in the epididymis. The drain is allowed to remain for three to six days.

After epididymotomy, pain and fever disappear with great rapidity, while the swelling of the epididymis and the residual induration go more quickly and more completely than with other methods of treatment. Patients are confined to bed after the operation for from four days to two weeks.

The treatment of all forms of epididymitis due to extension of inflammation from the posterior urethra is conducted on the lines laid down in regard to the gonorrhœal variety. Urethritis which is intensified by gout should be subjected to antilithæmic remedies, and appropriate diet and hygiene should be ordered. The harassing recurring epididymitis from which prostatics who are compelled to pass the catheter suffer should be prevented by vasectomy, and the operation should be performed for the relief of all forms of recurring epididymitis of urethral origin when the patient is past the procreative age. For the operative cure of sterility following double obliterating epididymitis, see page 452.

EPIDIDYMO-ORCHITIS COMPLICATING ACUTE INFECTIOUS DISEASES

Under this general heading are included orchitis of mumps, variola, typhoid, malaria, scarlatina, influenza, and possibly gout. Inflammation in most of these cases is of pure hæmatogenous origin, dependent upon toxic substances circulating in the blood. It apparently attacks primarily and most severely the testis. When the disease develops in its acute form the symptoms are even more marked than those of acute epididymitis. In the latter affection the bulk of the tumor is formed by the epididymis, which partly envelops the testis as would a hand a small kidney. In orchitis the main swelling is formed by the testis, this gland, even though enormously swollen, maintaining its normal form; the epididymis, if uninvolved, is stretched as a narrow band along its posterior border. The general testicular sensibility is greatly increased. Acute hydrocele may occur coincidently with the swelling of the testis, but is much less common than when the epididymis is involved. Exceptionally suppuration ensues; this is nearly always preceded by great œdema and discoloration of the scrotum and by pronounced constitutional symptoms.

The differential diagnosis between orchitis and epididymitis is based mainly upon the form of the swelling. When the tissues of the scrotum become markedly œdematous, and particularly when hydrocele develops, a differential diagnosis may be impossible; nor is this of cardinal importance.

Orchitis Complicating Mumps.—Inflammation of the testicle is sometimes the sole expression of mumps; it runs an acute course, terminating in a few days or a few weeks.

It may be ushered in by a rise of temperature, and generally develops from the fourth to the sixth day of the disease. As a rule, only one testis is involved. Catrin, basing his conclusion on a study of one hundred and fifty-nine cases of mumps, states that orchitis occurs in one out of three cases, usually develops after the parotitis, and begins in the epididymis, the body of the gland being subsequently attacked. In a certain number of cases after a period of atrophy and loss of consistency the testicle regains its original volume and firmness. If both testes become involved the inflammation is usually consecutive.

The inflammation of this form of orchitis begins in the gland and not in the epididymis, and incurable atrophy is a much commoner sequel than is generally conceded. Hornus observed a fatal case of orchitis consecutive to mumps. Death was caused by peritonitis, the testicles having been absolutely destroyed and converted into a purulent collection.

As to the etiology of the testicular affection, Kocher states that orchitis after mumps is urethral, the specific inflammation excited by the organism first involving the urethral mucous membrane and then extending along the vas. If this were true, we should expect the inflammation to develop first in the epididymis, as in the case of most inflammations of urethral origin. With the exception of Catrin, authors generally teach that the testis is primarily involved. The symptoms of mumps orchitis are pain, swelling, exquisite tenderness, and fever of moderate degree. Exceptionally the attack is ushered in with typical symptoms of acute peritonitis—*i.e.*, vomiting, constipation, tympany, and peritoneal tenderness; still more rarely by acute nephritis with uræmia.

Diagnosis.—The diagnosis is founded upon associated symptoms of parotitis, or, in the rare cases when these are latent or absent, upon the possibility of contagion and the exclusion of other sufficient causes of inflammation.

Prognosis.—This should always be guarded. In light attacks characterized by moderate swelling the prognosis is doubtless favorable. In severe attacks with pronounced general symptoms, and especially when the attack is prolonged, atrophy is always to be dreaded.

Treatment.—The measures already described as appropriate to orchitis and epididymitis are indicated when the testis becomes inflamed as an expression of mumps.

As a prophylactic treatment in all cases of parotitis it is well to support the scrotum by a soft flannel binder or a suspensory bandage, in accordance with the age of the patient. The comparatively unyielding tunica albuginea subjects the secreting substance of the testis to fatal pressure when inflammation is pronounced or is of long standing. This can be relieved at once by incision or puncture. The profession has been deterred from this form of intervention by the fear of hernia testis—*i.e.*, extrusion of the secreting substance of the testicle. When this has occurred it has been in consequence of infection; even though a certain amount of testicular substance should be lost as a result of incision, it is probable that the ultimate functional power of the organ would be better than it is when tension has been unrelieved.

Typhoid orchitis is commonest before the age of puberty. As a rule, it is mild in type and occurs during convalescence. The etiology of this condition is somtimes dependent on venous thrombosis, though it may be the result of infection from the urethra or through the agency of the blood. The typhoid bacillus has been found in suppurative cases. Atrophy is rare.

Malarial Orchitis.—This form of inflammation is chronic in type, with acute paroxysms, sometimes recurring regularly. In one case we noted acute pain and exquisite tenderness developing daily with the regularity that characterizes a quotidian type of malaria. The condition yielded promptly and completely to full doses of quinine.

Le Dentu states that the testicle slowly increases in size, becoming elephantiastic. He describes a form of overgrowth associated with elephantiasis of the scrotum and evidently dependent upon involvement of the lymphatic system. This is characterized by recurrent erysipelatoid attacks, with gradual deposi-

tion of partially organized fibrous tissue. It is probable that this is not malarial orchitis, but a distinct affection.

The principal diagnostic features of malarial orchitis are the recurrence of attacks and the absence of other sufficient cause for the symptoms. Examination of the blood and full dosage with quinine will establish the diagnosis and relieve the condition.

Orchitis following tonsillitis is an expression of infection which may be hæmatogenous or may be carried from the urethra. The course of the affection is similar to that of orchitis complicating mumps. The disease lasts two or three weeks and usually terminates in resolution, but may suppurate or become chronic, in either case ultimately causing atrophy.

Gouty orchitis is found associated with the usual phenomena of gout. It may be acute or chronic in type, and is likely to be persistent. It may, however, alternate with other gouty symptoms, disappearing with the arthritis and reappearing as the latter subsides. It is prone to relapse, occurring in sudden seizures, and may be transferred from one testicle to the other. True gouty orchitis is quite different from the epididymitis of urethral origin observed in gouty persons. It occurs after middle life, and affects primarily and chiefly the testis, rarely extending to the epididymis.

Orchitis following small-pox, scarlatina, or influenza has no pathognomonic features. It is simply a local expression of a general infection, due either to lodgement of microörganisms circulating in the blood or to extension by means of a phlebitis, especially of the spermatic veins.

Traumatic orchitis has been already discussed.

By whatever cause orchitis or orchi-epididymitis is excited, the lesions, symptoms, and terminations are practically the same, with minor differences dependent upon a difference in the virulence of the infection and upon varying individual power of resistance. The distinction between inflammations of urethral and those of hæmatogenous origin is important mainly from a therapeutic standpoint, since a posterior urethritis if present should receive attention.

The inflammation may terminate in complete resolution with restoration of physiological function, in chronic inflammation followed by atrophy and loss of function, or in abscess often complicated by fungus of the testicle. Gangrène is a rare complication occurring in debilitated patients. Exceptionally the inflammation extends along the cord, occasioning pelvic cellulitis and peritonitis. We believe, however, that most of the reported cases of this extension are in reality instances of suppuration of the seminal vesicles. The initial cause of chronic inflammation is usually a preceding acute orchitis, although underlying this there is often a constitutional dyscrasia. Either the testicle becomes indurated and completely atrophies, or suppuration takes place, producing multiple abscess.

Treatment.—Acute orchitis is treated by the remedies and applications described as appropriate to gonorrhœal epididymitis. The indications are met by rest in bed, elevation of the pelvis and the testicles, the application of evaporating lotions or the ice-bag, or hot fomentations, according to the severity of the inflammation, securing a free movement of the bowels, and the administration of febrifuges and diuretics, and of morphine hypodermically in sufficient doses to control the severe pain.

If the pain is so intense that safe doses of morphine will not relieve it, the tunica albuginea may be punctured. The punctures should be made with a straight cataract knife; they may be multiple and may be repeated several times. The importance of guarding against infection is evident. Abscesses should be opened and drained by gauze packing; rheumatic and gouty cases should receive appropriate constitutional treatment, and invariably on the subsidence of acute inflammation the general treatment of the patient should be tonic and supporting.

As soon as patients are able to leave bed, and when the inflammation is moderately severe this should not be under two or three weeks, a carefully fitted pressure suspensory bandage should be worn, preferably that described in the treatment of gonorrhœal epididymitis, and this should be continued for months or until the testicle returns to its normal condition. At the same time a slightly stimulating ointment applied to the scrotal skin will be serviceable. One reason that acute orchitis and orchi-epididymitis run into the chronic form and produce slow destruction of the secreting portion of the testes is that patients are allowed to be up and about before blood-vessels have regained their tonicity, and hence there results a condition of chronic congestion in a previously inflamed organ. Prolonged rest in bed and an accurately fitting pressure bandage are the means of treatment which offer most hope of avoiding this complication.

Abscess of the Testicle

Reference has been already made to abscess as a comparatively rare termination of acute or chronic orchitis and epididymitis. In tuberculous, malignant, or syphilitic degeneration of the testicles pus-formation is common. In gonorrhœa and mumps it is rarer than in other acute infectious diseases. It is probably most frequent in the epididymo-orchitis which develops in old men in consequence of catheter urethritis (Fig. 164).

A small abscess having formed in the testis, it may become encysted, undergoing caseous degeneration (Fig. 165); or it may spread beneath the tunica albuginea, involving the whole testis and causing sloughing, followed by many openings; or may rupture into the tunica vaginalis, causing suppuration of this sac and ultimately pointing externally; or the abscess may reach the surface without rupturing into the cavity of the tunica vaginalis, inflammatory adhesions gluing all the tissues together before the pus breaks through the tunica albuginea.

Sometimes the abscess when centrally placed may remain quiescent for an indefinite period, occasionally exhibiting acute exacerbations.

The symptoms of suppuration are those of an aggravated orchitis. Usually there is fever and the œdematous swelling of the scrotum becomes more pronounced. Following incision or spontaneous evacuation, fungus of the testicle may develop, the whole of the secreting substance of the gland being extruded.

Treatment.—Early free incision, followed by irrigation and gauze drainage, is the treatment best calculated to relieve tension, and therefore to lessen the danger of acute tissue necrosis. Healing is usually prompt. When the whole testis is riddled with abscesses, or when sloughing has taken place, castration is the operation of choice.

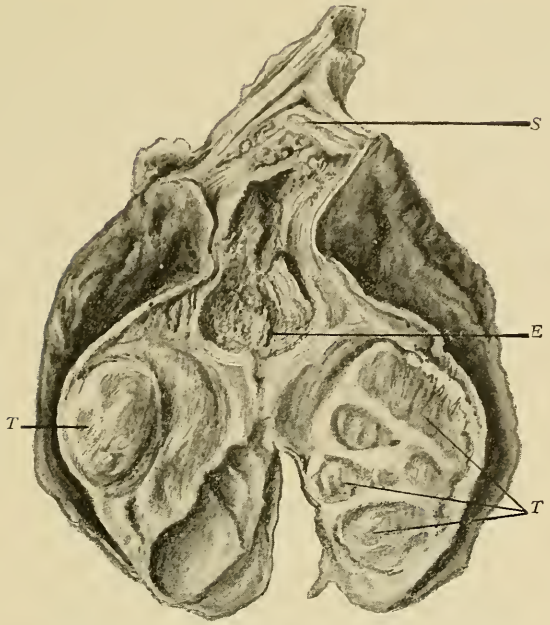


FIG. 164.—Suppuration epididymo orchitis. *E*, abscess of epididymis; *T*, abscess cavities in body of testicle; *S*, spermatic cord. (No. 1687, Laboratory of Surgical Pathology, University of Pennsylvania.)

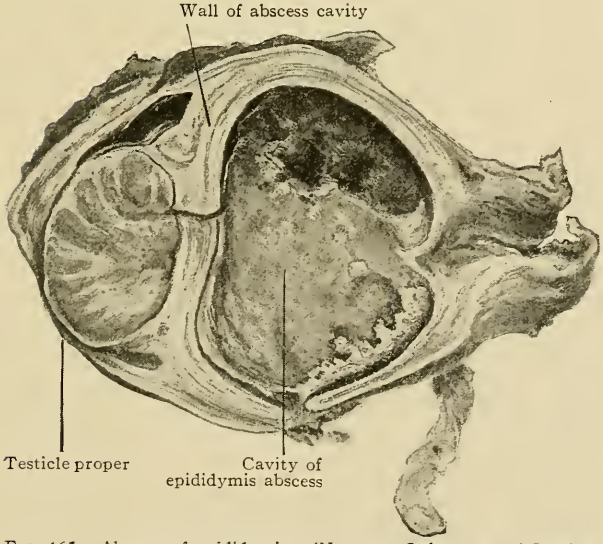


FIG. 165.—Abscess of epididymis. (No. 3217, Laboratory of Surgical Pathology, University of Pennsylvania.

Fungus or Hernia of the Testicle.—The older writers described a hernia testis apparently due to simple infection following, for instance, such a procedure as puncture of the tunica albuginea for relief of pain in a gonorrhœal epididymitis. We have once encountered such a condition which was neither tuberculous nor syphilitic, but was an instance of sloughing testis, in which the devitalized tissues gradually escaped through an infected and bruised trochar opening.

Fungus which accompanies suppurative or sloughing processes may be made up entirely of granulation-tissue. This is always the case in the parietal form of the affection. In the glandular or deep form the tubular structure of the testis is often extruded, though absence of the tubules in the slough and discharge does not prove that the granulations do not grow from the gland.

The tuberculous fungus may be superficial or deep, and is made up of exuberant granulations from the walls of an abscess. These protrude through openings in the scrotum which exhibit indurated, chronically inflamed, gradually contracting borders; they appear as yellowish-red, painless, cauliflower-like growths, overlapping the scrotal defect, rarely larger than the end of the thumb, though in the glandular variety the greater part of the testicular substance may be extruded.

The syphilitic fungus grows from the walls of a discharging gumma; it may be intra- or extra-glandular; it rarely attains the size of the tuberculous fungus.

The malignant fungus (fungus hæmatodes) is in reality a new growth which has broken through the tissues of the scrotum.

Treatment.—This depends upon the cause and the variety of the fungus. Syphilitic cases are cured by an appropriate constitutional treatment, supplemented by cutting away the exuberant granulations and dressing the wound with sterile gauze. Tuberculous cases, if superficial, may be cured by touching with caustic potash and dressing with iodoform gauze. If deep, they should be opened, curetted from the bottom, and packed; if persistent and associated with extensive degeneration of the testicle, castration should be performed. Fungus hæmatodes (malignant) should be treated by castration.

The fungus which complicates simple abscess or sloughing, and which springs from the glandular substance, being made up of granulation-tissue and sometimes of seminiferous tubules, should be opened and curetted and the resulting wound packed with gauze.

TUBERCULOSIS OF THE TESTICLE

Tuberculous inflammation first attacking the epididymis may develop very exceptionally as a sudden outbreak with all the local and general symptoms of acute inflammation, leaving on subsidence an irregular nodulation characteristic of tuberculosis; usually as a slow, apparently non-inflammatory, almost painless formation of tuberculous nodules.

The infection may reach the testicles through the blood-channels or may extend along the vas. Occasionally the testicles are affected during the evolution of a general miliary tuberculosis. The lodgement of the tubercle bacili may be primary in the epididymis, or the infection may be secondary to prostatic, vesical, or renal tuberculosis, or to foci of the disease in other parts of the body.

So far as clinical evidence goes, the epididymis appears to be a frequent seat of primary tuberculosis; from this organ as the starting-point the disease extends along the genito-urinary tract. Saltzmann defends the theory of the entrance of the bacilli by way of the blood-vessels on the ground that the arteries of the epididymis are smaller and more tortuous than those of the testis or of the vas, and that thus bacilli floating in the blood are more liable to be lodged.

It is possible that infection may take place during coitus. Verneuil strongly defends this theory. He demonstrates the presence of tubercle bacilli in the discharges of patients suffering from uterine tuberculosis, and cites cases in which the disease appeared in persons of perfectly healthy constitution after sexual intercourse with women so affected. This belief in immediate tuberculous contagion is sufficiently well grounded to justify a careful examination of uterine and vaginal discharges in suspected cases, and, when bacilli are found, to make it desirable to suggest means of prophylaxis.

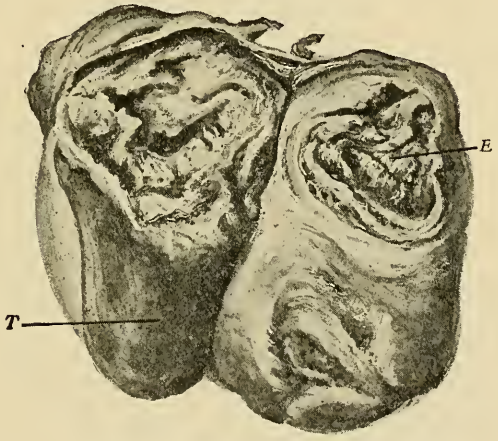


FIG. 166.—Tuberculous epididymitis. *E*, epididymis involved in the caseating tuberculous process, *T*, body of testicle free from disease. (No. 500, Laboratory of Surgical Pathology, University of Pennsylvania.)

Tubercle bacilli have been found in the healthy testis and epididymis. It is also proved that these organisms may circulate in the blood without obtaining lodgement in the tissues, and consequently without working deleteriously upon the system until acute inflammation, particularly that following traumatism, produces a local lessening of resistance which favors the lodgement and multiplication of the microörganisms. This has been shown experimentally by intraperitoneal injection of tuberculous sputum followed by contusion of the testis, and suggests that an acute gonorrhœal epididymitis or an orchitis incident to traumatism may predispose to tuberculous infiltration.

In the large majority of cases tuberculous infiltration is first noted in the head of the epididymis, appearing as indolent nodules which sooner or later undergo cheesy degeneration (Fig. 166). The epididymis becomes irregularly infiltrated, and the vas thickened, hard, and nodular. The disease also extends in the direction of the testis, and not infrequently the vaginal tunic is

involved. When the testis is infected, similar nodules develop and show a central degeneration, extending at the same time peripherally, and finally forming a comparatively large cavity (Fig. 167).

Though from clinical examination in the vast majority of cases tuberculosis seems primarily to involve the epididymis, entirely sparing the testis, Reclus has shown by post-mortem dissection that in the later stages of the disease both epididymis and testis are involved in more than three-fourths of the cases.

Symptoms.—Tuberculous epididymo-orchitis may develop abruptly or insidiously, or may be preceded by certain highly characteristic prodromal symptoms.

The abrupt development of the disease commonly is dependent upon slight trauma or extension of inflammation from posterior urethritis. The symptoms

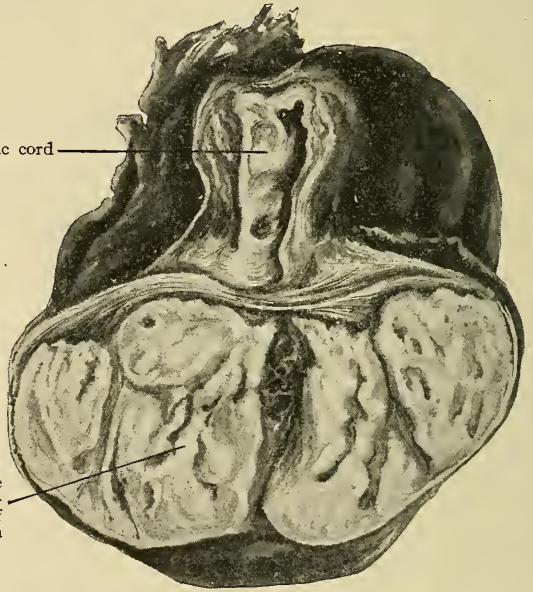


Fig. 167.—Tuberculosis of the testicle. (Laboratory of Surgical Pathology, University of Pennsylvania.)

are practically the same as those of traumatic orchitis or of gonorrhœal epididymitis. There are the characteristic sickening pain, effusion into the tunica vaginalis and the cellular tissues about the epididymis, and general œdema. Instead of subsiding in the course of a few days or one or two weeks, the local swelling persists, though pain may be almost entirely relieved. In a few weeks fluctuation may be detected, and one or more sinuses form, discharging cheesy pus, or the formation of fistulæ may be a late development.

The inflammation is commonly an epididymo-orchitis, and is often bilateral. It attacks by preference young adults, and is first lodged in the epididymis, the outlines of which are so obscured by a large bossed swelling that the loop formed by the vas deferens cannot be felt (Reclus); the vas is often infiltrated, and there may be tuberculous involvement of the other genito-urinary organs,

particularly the prostate and seminal vesicles. Except during the period of acute outbreak there is little or no pain. Hydrocele generally develops in connection with this form of tuberculosis, and is likely to be of the agglutinative type. In the discharge from the sinuses tubercle bacilli may be found.

The usual insidious form of the disease is characterized by the slow, painless formation of nodules either in the epididymis or in the testicle, or in both these organs. Frequently there are absolutely no symptoms, the patient detecting the overgrowth accidentally. Sometimes there is a sense of dragging weight, or there are reflex disturbances, such as frequent emissions or sexual hyperæsthesia, which lead to examination of the part and discovery of the swelling.

In the chronic forms of tuberculous involvement of the testis and epididymis suppuration and abscess-formation develop much more slowly than in the acute. Even large infiltrations become encapsulated and absorbed, leaving simply irregular fibroid nodulations. We have under observation a few cases of tuberculous epididymo-orchitis which have lasted from ten to twenty years, and in place of softening and breaking down have undergone a steady fibroid change. When fistulæ are formed, usually in the lower posterior part of the scrotum, they continue to discharge a thin serous fluid, often containing broken-down granulations, until the degenerated tissue is entirely eliminated; they then heal, unless there is extension of infiltration.

The form of the disease ushered in by prodromata is probably not primary; *i.e.*, there is a pre-existing tuberculous involvement of some other portion of the genito-urinary tract. The prodromal symptoms are—(1) A painless, moderate urethritis, characterized by a scanty, turbid, mucopurulent discharge, noticeable only in the morning. This discharge comes and goes apparently without cause, and is uninfluenced by treatment. (2) Frequent urination. (3) A hypersensitive condition of the prostatic urethra, particularly to instrumental examination and irritating injections. (4) Terminal hæmaturia. These symptoms may last weeks or months before appreciable development of lesions in the testis or the epididymis, and indicate tuberculous involvement of the vesicles, vasal ampullæ, or posterior urethra.

Diagnosis.—The diagnosis of acute tuberculous epididymo-orchitis is based on—(1) The apparently causeless outbreak of acute inflammation. When traumatism, mumps, gonorrhœa, syphilis, and the various infectious diseases can be excluded, tuberculosis should be suspected. (2) The presence of tuberculous infiltration in the prostate or seminal vesicles or evidences of infection in other parts of the body. (3) Persistence of swelling after the pain and other symptoms of acute inflammation have subsided. (4) Formation of nodules, particularly in the region of the epididymis, which soften and break down, leaving fistulæ, in the discharge of which may be found tubercle bacilli.

Acute tuberculous epididymitis commonly develops in young adults of lymphatic temperament who have a tuberculous family history. The pain and swelling are somewhat less marked than in cases of gonorrhœal epididymitis, for instance. It must be confessed that in the first one or two weeks of an attack it may be impossible to establish a diagnosis. The formation of suppurating

nodules is, however, characteristic. The cord is soon involved, becoming thickened and irregularly bosselated.

The diagnosis of chronic tuberculous epididymo-orchitis is based upon a tuberculous history, the painless noninflammatory development of infiltration, particularly in the head of the epididymis, the association with nongonorrhœal urethral discharge, frequent urination, and hæmaturia, the discovery of induration or nodulation of the seminal vesicles or prostate, the gradual extension of the infiltration to the entire epididymis and to the cord, often forming an irregular tumor much larger than the testis, and finally upon the tuberculin test and bacteriological examination. When there is an associated hydrocele (and this is common), injection of this fluid into the peritoneal cavity of rabbits may cause the development of miliary nodules. The urethral discharges should be carefully examined for tubercle bacilli. It must be remembered that it is possible for gonorrhœal epididymitis to develop and run its typical course in the tuberculous subject without subsequent tuberculous infiltration of the epididymis or testis.

Differential diagnosis between the tuberculous nodule and the induration following gonorrhœa is based upon the history of a preceding acute urethritis and upon the fact that the gonorrhœal induration is found in the tail of the epididymis, while the tuberculous nodule is usually in the head. The gonorrhœal nodule exhibits no tendency toward extension, does not mask the outlines of the epididymis, and is not associated with palpable lesions of the cord.

The differential diagnosis between acute gonorrhœal epididymitis and acute tuberculous epididymitis in the absence of other tuberculous lesions must be held in abeyance until the tuberculous process develops with characteristic features. The finding of the gonococcus does not necessarily exclude tubercle.

Prognosis.—It has been already stated that tuberculous nodules may become encapsulated and absorbed, leaving a mass of fibrous tissue to mark their position. This does not necessarily indicate that a definite cure has been accomplished, since under favoring circumstances the tuberculous foci may again become active and with greatly increased virulence. Yet when the infection is located only in the epididymis or testis, spontaneous cure may result from this process of encapsulation.

The course of the case will be unfavorable in direct ratio to (1) the rapidity of development; (2) the extent of involvement of the gland; (3) the tendency to become bilateral; (4) the association with diffuse urogenital tuberculosis.

In any event it cannot be too strongly emphasized that, as in all other forms of surgical tuberculosis, the prognosis is extremely grave if the patient is necessarily intrusted to the *vis medicatrix naturæ*.

When the tuberculous process is lodged solely in the epididymis or the testis and is subjected to prompt surgical treatment, the prognosis is favorable. When the affection is bilateral, involving the cord, seminal vesicles, and prostate, surgical intervention promises little success; the main dependence must be placed on constitutional hygienic treatment.

Treatment.—1. Palliative Treatment.—When a patient suffering from tuberculous epididymo-orchitis will not submit to operation, or when the disease is so wide-spread that its complete removal is impossible, hygienic measures

adapted to tuberculous patients generally are indicated. The most efficient of these is probably out-door life in a suitable climate. The testicles should be protected and supported by the pressure suspensory bandage described in the treatment of gonorrhœal epididymitis or by a well-fitting jock-strap.

2. **Radical treatment,** when the disease is strictly localized—*i.e.,* when it appears in the form of small, separate nodules or foci of caseation—may consist in epididymectomy, or in incision, followed by vigorous scraping of the infected tissues and packing with iodoform gauze.

Excision of the epididymis or a portion of the testis is indicated when there is reason to believe that a considerable part of the gland may be safely left. An incision is made on the outer posterior scrotal surface and the epididymis is cut away from below upward, the blood-vessels lying along its inner border being spared. So much of the vas as is readily accessible should be removed.

Injections of ten per cent. emulsion of iodoform in glycerine have given excellent results, and are particularly indicated when the disease is bilateral and cannot be eradicated by erasion or excision of the epididymis. From five to fifteen drops of this mixture should be employed for one treatment, and should be driven directly into the infiltrated mass, the needle being introduced at several points and two or three drops deposited at each. The injections are repeated every third or fourth day, depending upon the violence of the reaction.

There can be no question as to the permanence of many cures reported from the injection treatment, though as a result the epididymis becomes hopelessly obliterated.

Castration is the final operation applicable to advanced cases. This treatment is indicated when the tuberculous involvement is too extensive to be removed by erasion as a partial operation, and when other tuberculous lesions are either absent or but moderate in extent.

When castration is performed, not only the testicle but all infiltrated skin and cellular tissue should be removed. The cord should be divided high up, and the vas should be followed beyond the limits of nodulation or infiltration, even into the pelvis, if this is required by the extent of the disease. When the vas is infiltrated through its entire length, the incision for castration should be extended from the scrotum upward parallel to Poupart's ligament and down to the peritoneum, which should be separated from the lateral walls of the bladder by the finger, using the vas deferens as a guide, until the top of the seminal vesicle is reached. The vas is divided at this point and extracted. Roux suggests that when the ampulla of the vas, the prostate, and the seminal vesicles are involved, a semilunar incision should be made in front of the anus, the rectum separated from the prostate, a transverse incision made in the fascia covering the seminal vesicles and vasa, and the diseased structures peeled off from the bladder and removed. Of eleven cases thus treated by Von Bünger eight were free from recurrence after more than five years; one died of miliary tuberculosis.

Haas has shown that double castration in cases of tuberculosis of the testicle is followed in over fifty per cent. of cases by radical cure, and does not cause mental or nervous disturbances. Subsequent to unilateral castration the disease appeared in the remaining testicle in one-fourth of the cases. Following any operation the hygienic and dietetic treatment appropriate to tuberculosis should be continued for a long time.

SYPHILIS OF THE TESTIS AND EPIDIDYMIS

Either portion of the testicle may be the site of syphilitic infection, and in either portion the disease may manifest itself either as a diffuse interstitial process or by the production of gummata. Though the onset is typically insidious, in occasional instances the signs of acute inflammation are present.

The tumor formed by gummata is nearly always painless, except from its weight. This infiltration may soften and break down, forming fistulæ or fungus, or may lead to atrophy of the gland.

The diagnosis of syphilitic epididymitis from the tuberculous affection is based on the density and the sharper demarcation of the syphilitic nodules, on the history of the case and the effect of constitutional treatment and the Wassermann reaction. Acute syphilitic orchitis is characterized by the primary development of the affection in the testis, by the evenness and hardness of the tumor,

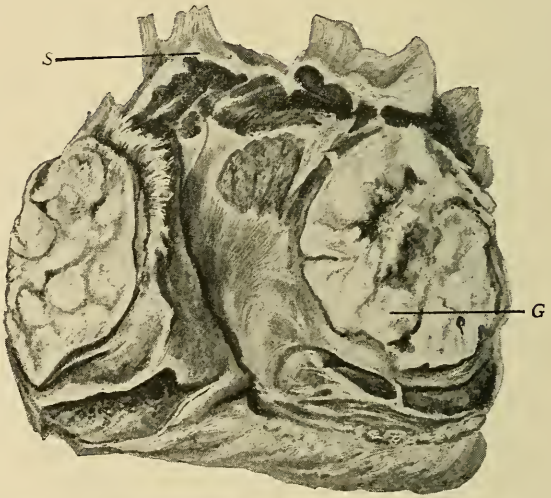


Fig. 168.—Gumma of testicle. *G*, gumma; *S*, spermatic cord. (No. 3541, Laboratory of Surgical Pathology, University of Pennsylvania.)

by the history of syphilis, by the absence of other sufficient cause for the disease, and by the effect of constitutional treatment. Gummatous orchitis differs from tuberculous disease in forming a larger, denser tumor before softening occurs, one that commonly involves the entire testis, and forming on its surface ridges or nodules. It never reaches the size of a man's fist before breaking down (Fig. 168). It is commonly masked in part by an associated hydrocele and is often bilateral. Gummatous fistulæ lead down to the testicle and open on the anterior surface of the scrotum, differing in both these respects from the tuberculous fistulæ, which originate in the epididymis, and commonly open on the side of the scrotum. The diagnosis between syphilitic and tuberculous orchitis may be impossible from inspection and palpation. The distinction of syphilitic sarcocele from hæmatoma is made on the history of the development of the tumor or upon the result of aspiration.

TUMORS OF THE TESTICLE

The usual tumor of the testicle is the teratoma. A variety of neoplasms have been described, resulting in a bewildering classification; incomplete sectioning of the tumors and the preponderance of a single element in large growths are probably responsible for the misconceptions, the complex nature of the tumors being unrecognized in many cases.

The following statements are based largely on Ewing's [1] monograph:

A few simple tumors have been described as springing from the testicle. They are all so rare as to be of no clinical importance.

Fibromata are of slow growth and symptomless. Less than a dozen have been reported, none in recent literature.

FIG. 169.—Lymphosarcoma of the testicle (bilateral).

Chondroma, Myxoma, Lipoma.—These tumors probably exist only as parts of teratomata.

Myoma.—A single case of undoubted leiomyoma has been reported, by Trelat. Rhabdomyoma seems to occur only as a part of a teratoma.

Adenoma.—The majority of the growths which have been described as adenomata have probably been teratomata, yet these tumors are occasionally encountered, usually of small size, originating from the tubules of the testis, especially in undescended testicles.

Sarcoma.—Primary lymphosarcoma is a rare tumor, though more common than any of the previously mentioned neoplasms. It is generally bilateral (Fig. 169), runs a rapid course, metastasizing to the skin as a rule. The existence

[1] Ewing, J.: "Teratoma Testis and Its Derivatives," *Surg., Gynec., and Obstet.*, March, 1911, p. 230.

of spindle-cell sarcoma is questioned; the occurrence of small round-cell sarcoma as a simple tumor is also doubtful (Fig. 170).

Carcinoma.—Cancerous tissue is found in almost all teratomata of the testicle. It also occurs in many cases in which a careful search has failed to discover teratomatous elements. Yet the general structure and the appearance of the cells in these tumors so closely resemble those found in the teratomata that the theory has been advanced that they are in reality one-sided developments of teratomata; this particularly in regard to adenocarcinoma and large alveolar carcinoma. The scirrhous and medullary forms as described by Langhans seem to have a better claim to be considered pure carcinoma (Figs. 171 and 172).

FIG. 170.—Sarcoma (teratoma) of the testicle. (No. 623, Laboratory of Surgical Pathology, University of Pennsylvania.)

Teratoma.—These mixed tumors arise typically, if not always, from the region of the rete testis. Trauma seems to be an etiological factor in a fair percentage of cases.

More than one-half the cases of teratoma of the testicle develop between the thirtieth and the fortieth years. The growth may be slow or rapid; if the latter, the size of a child's head may be, rarely, attained.

The tumor usually corresponds to the form of the testis until it has thinned or perforated the albuginea, when it becomes irregular and nodulated. The tunica vaginalis is partly obliterated by adhesions; the portions not thus closed are filled with blood-stained serum. As the tumor proliferates it may involve

and destroy the skin, forming a cauliflower-like mass of bleeding granulations (fungus hæmatodes).

The consistence of the tumor varies greatly; often nodulations alternating with areas of softening are felt throughout its substance; it may exhibit parenchymatous hemorrhages or various degenerations, as mucoid or colloid.

In the early stages the epididymis may often be felt entirely uninvolved. Later it becomes infiltrated and indistinguishable from the mass of the tumor. Hydrocele or hæmatocele may complicate the affection from the beginning and conceal the enlargement.

The swelling often develops without pain, though rarely when the growth is

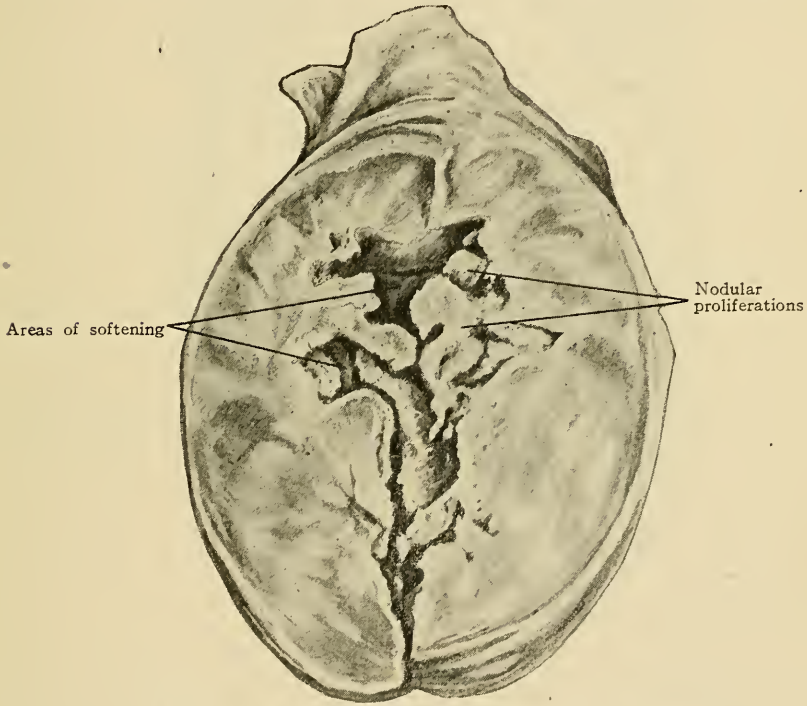


FIG. 171.—Carcinoma (teratoma) of the testicle. (No. 3249. From the Museum of the Wistar Institute.)

very rapid; testicular sensation is lost early. The first symptom of lymphatic involvement may be pains referred to the inguinal region or the back, or along the course of the sciatic nerve, or radiating down the thighs. The enlarged retroperitoneal nodes may cause œdema of the legs by pressure on the veins. They can often be felt through the abdominal wall. The inguinal nodes are not enlarged until the scrotum becomes involved. Cachexia becomes marked when secondary deposits develop. The vessels of the cord become very large, thus differing from the swelling caused by simple hydrocele. Moreover, the scrotal veins are nearly always dilated.

O'Crowley and Martland (personal communication; see also Transactions

of the American Urological Association, 1917) consider "that for all practical purposes there is but one tumor of the testicle, namely, a teratoma, and the most common neoplasm is the alveolar carcinoma with lymphoid stroma; the vast number of the varieties of testicular tumors which have been described is due to incomplete examination—if the whole mass be examined, serial sections being necessary in some instances, every case will be found to be teratomatous.

"The tumor metastasizes as carcinoma, the retroperitoneal lymph-nodes being involved in the vast majority of cases.

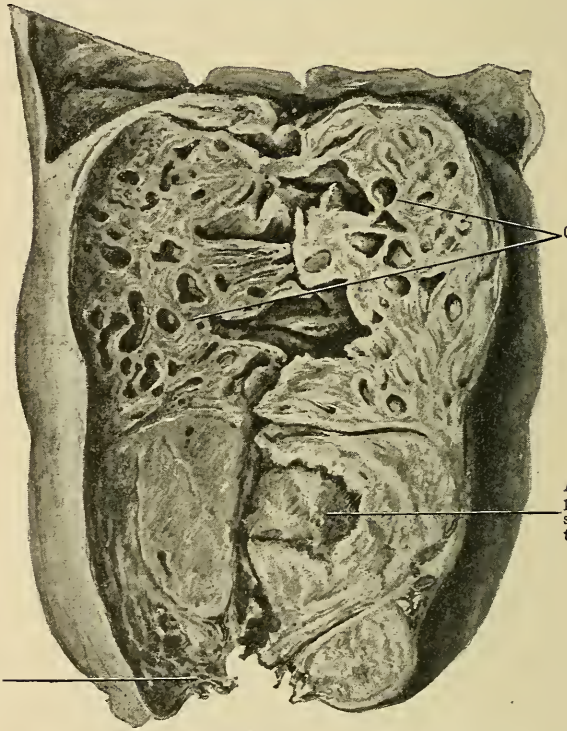


FIG. 172.—Cystoma (teratoma) of the testicle. (No. 3246. From the Museum of the Wistar Institute.)

"The growth is to be differentiated from tuberculosis and gumma of the testicle."

From a histological standpoint, teratomata contain tissue derived from two or three of the primitive germinal layers. In most cases one of these predominates, so that unless the whole tumor be carefully examined there is danger of not appreciating its mixed character. In the majority of cases the great mass of the growth is composed of carcinomatous tissue with lymphoid stroma. Islands of cartilage are found in many tumors; muscle is less often seen; thyroid tissue is a fairly frequent finding.

Diagnosis.—An apparently causeless induration of the testicle, followed by rapid and progressive increase in size with little alteration in form, is indicative of malignant growth if tuberculosis and syphilis be excluded; and, as

already indicated, for practical purposes a malignant growth of the testicle is a teratoma. Marked dilatation of the blood-vessels of the cord and scrotum is highly characteristic. When the tumor is masked by hydrocele, the latter should be treated by open incision, thus allowing the testis to be inspected and palpated.

Malignant growth following traumatism may be distinguished from traumatic orchitis only by the progressive increase in the size of the testis. When the teratoma is thoroughly developed it is not likely to be confounded with any other affection (Fig. 173). The large tumor, the infiltration of the cord, the involvement of lymphatic nodes, the discoloration of the scrotum, the enlargement of the blood-vessels, and finally the cachexia, are all characteristic. Gum-

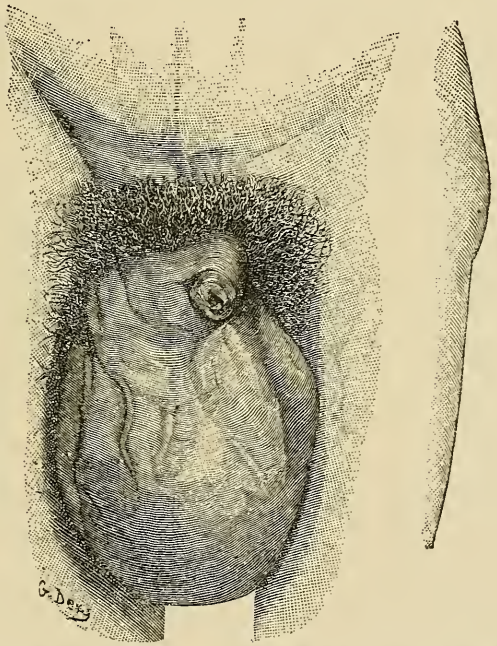


Fig. 173.—Cancer (teratoma) of the right testicle. (Monod and Terrillon.)

ma of the testicle never grows larger than the size of the fist, and does not enlarge the nodes. Moreover, it is sometimes bilateral, the patient's blood gives a positive Wassermann reaction, and the tumor yields to specific treatment.

Hæmatocele may be mistaken for malignant disease. There should, however, be a history either of trauma with a growth developing within a few hours, or of an old hydrocele into which hemorrhage may have occurred. In hæmatocele pain is an early symptom, and the swelling increases intermittently and not by steady growth; it is less bossed and irregular than is malignant disease; testicular sensation is not so completely lost. Tapping may establish a diagnosis, though it must be remembered that there is often blood effusion into the tunica vaginalis in cases of malignant disease.

An old hydrocele with thickened sac, containing fibro-cartilaginous material,

and exhibiting a hard and uneven surface, may resemble the hard form of the malignant disease. When it is impossible to distinguish between these two affections, an early incision, followed by an operation appropriate to the condition found, is advisable.

Prognosis.—The prognosis of teratoma of the testicle is bad, particularly when the retroperitoneal nodes are involved. Paget states that the duration of life is, on an average, twenty-three months, patients living about six months after operation since, as a rule, they do not consent to surgical intervention until they have suffered from the disease for one and a half years. Death is nearly always due to metastasis. The scirrhous form of the disease runs a slow course: Nepveu reports one case which survived fifteen years.

A few cases of radical cure have been recorded. Winiwarter, among twelve cases, found one living two years and seven months after operation. Robin and Volkmann report four cases as living three years. Kocher publishes the records of six cases; two were well one year after operation, one one and a half years, one four and a half years, one eight and a half years, one ten and a half years; in only one instance was the operation performed early.

Treatment.—Orchidectomy, with removal of the cord up as far as the internal ring, the customary operation for the condition, has an ultimate mortality of almost 100 per cent. A more extensive operation, consisting of, in addition, incision of the abdominal wall down to the peritoneum from the internal ring upward to the costal margin, and stripping forward the serous membrane till the aorta and cava are exposed, so that the retroperitoneal lymphatic tissue may be removed, seems to promise better results. The testicular tumor should be removed, incised, and examined before proceeding with the last stage of the operation.

Castration or Orchidectomy

Castration is attended with little danger. Preliminary cleansing of the operative region should be repeated several times, at intervals of some hours, and immediately before operation the penis should be tightly bandaged in sterile gauze, since it is a frequent source of infection in operations about the genitalia.

The incision varies in accordance with the conditions. When the tumor is small and non-adherent and the cord is not involved, an opening over the external abdominal ring large enough to allow the tumor to be pulled out suffices. If the growth is large, adherent, and extending up the cord, the incision should be continued parallel with Poupart's ligament, half an inch above it, to the position of the internal ring or beyond this. Diseased tissue should be avoided in making the dissection, the vaginal tunic and the greater part of the scrotal tissues of the affected side being taken with the growth.

It is advisable to remove as much as possible of the cord when any portion of this structure is involved in the malignant process, splitting the aponeurosis of the external oblique to expose the portion in the inguinal canal. When there is need for haste it may be transfixed with a gut suture, tied in two portions, and divided, the stump of the vas being cauterized with phenol. It is a little safer, however, to cut through the cremaster and secure the spermatic, cremasteric, and deferential arteries separately; the veins may be tied in one or two masses. The deferential artery is found close to the vas, and with it are a few veins; the cremasteric lies to the outer side of the cord, near its surface; the spermatic

is in front of the cord, surrounded by the anterior group of veins, and can scarcely be distinguished from them. The divided cord should be secured with artery forceps until the end of the operation. The bleeding from the scrotal tissues is controlled by forcipressure or ligatures, and redundant portions of the scrotum, particularly those which may be infiltrated, are removed. The edges of the wound are then approximated, care being taken to prevent inversion by the dartos. The sutures should be of silk; the last one may secure a drainage-tube in the lower angle of the wound if the case has been an infected one. Otherwise drainage is unnecessary.

An aseptic dressing is applied and held in place by the crossed bandage of the perineum.

The patient may sometimes complain of retention of urine, lasting from twenty-four to thirty-six hours. This is best relieved by enemata of hot saline solution. Should this fail, the catheter may be used. The stitches are removed on the fifth to the seventh day.

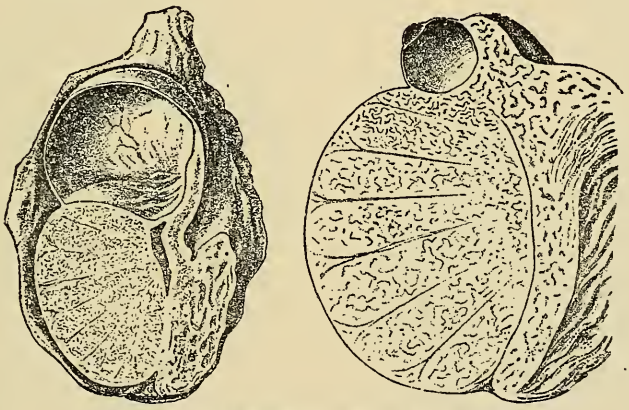


FIG. 174.—Intravaginal spermatocele. (Hochenegg.)

CYSTS, OR ENCYSTED HYDROCELE, OF THE EPIDIDYMIS AND TESTIS.—In this affection the fluid is contained in distinct cysts, which may or may not project into the cavity of the vaginal tunic; this tunic, or at least its parietal layer, does not form the walls of the cysts. These cysts may originate in the epididymis, in fœtal structures lying near by, or in the testicle (Fig. 174). They may contain a milky fluid, which under the microscope is found to be filled with spermatozoa (this is particularly true of the larger cysts), or their contents may be perfectly translucent, but differing markedly from hydrocele in composition, since they contain little or no albumen.

Cysts of the Epididymis.—These cysts may be small or large; the small cysts are usually multiple, and, according to Gosselin, develop in the majority of testes after middle life. They may be very minute or are large as a pea, and are sometimes pedunculated. They are easily shelled out from the surrounding tissue. Exceptionally they contain spermatozoa. They are placed both on the surface and in the parenchyma of the epididymis. While they may develop

from the remnants of fœtal structure, it seems more probable that they are involution cysts, originating in the tissue of the epididymis, but becoming subserous.

The large cysts are parenchymatous, arising beneath the outer covering of the epididymis and close to its upper part, or between it and the upper part of the testicle (Fig. 175). They lie outside of the visceral layer of the vaginal tunic, pushing this upward as they become distended, and are in close contact with the seminal ducts. They are usually single, but may be multiple or multilocular. Commonly the fluid is milky from the spermatozoa which it

FIG. 175.—Encysted hydrocele (large cysts).

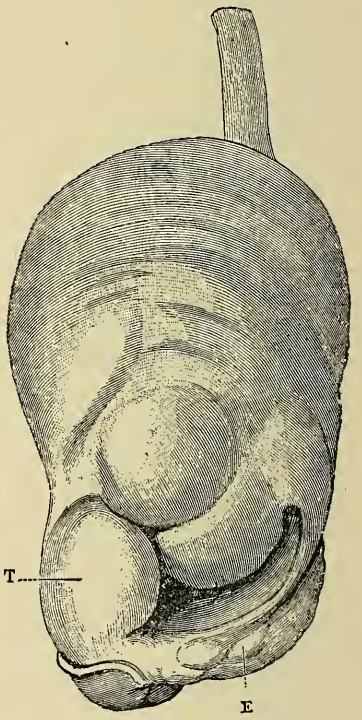


FIG. 176.—Multilocular cyst of the epididymis. T, testicle; E. epididymis displaced by the cyst. (Monod and Terrillon.)

contains, though it may be limpid. These cysts may arise from retention cysts or from the development of the fœtal remains. Spermatozoa may find their entrance into them through minute openings, difficult to recognize at any time, and capable of closing before the cyst is examined. They rarely attain great dimensions, containing on an average not more than two or three ounces of fluid. Exceptionally they may form large tumors (Fig. 176). They are not confined to old age, developing at any time after full sexual maturity.

Morris states that the cyst may originate as a retention cyst due to dilatation of a seminal tube, owing to some obstruction in the vas deferens or other

part of the excretory passages (Liston, Luschka, and others); or as a new formation in the connective tissue between the tubes of the epididymis subsequent upon the rupture of a seminal tubule and the escape of some drops of seminal fluid. The opening in the duct may afterwards cicatrize, so that there need not persist a communication between the duct and the new-formed cyst.

The cyst may be formed originally in the connective tissue, and by gradually enlarging may cause subsequently the rupture of a seminal tubule, and thus the entrance into the cyst of spermatozoa (Curling).

The fœtal structures from which cysts of the epididymis originate are—(1) The paradidymis, or organ of Giraldès, a minute body, the remnant of the mesonephros or glandular portion of the Wolffian body. This is situated in front of the lower part of the vas and above the head of the epididymis and behind the upper part of the tunica vaginalis. Cysts having this origin are situated above the testis and epididymis, and extend sometimes a little way along the cord. They correspond to paroöphoritic cysts in the female. (2) The ducts of Kobelt, which are remnants of the tubules of the Wolffian body, situated in the globus major. (3) The vestiges of the duct of Müller, part of which is represented by the hydatid of Morgagni, can sometimes be traced from the globus major down to the globus minor, along the body of the epididymis in the digital pouch. Cysts derived from these sources are situated between the epididymis and testis, most frequently between the globus major and the upper end of the testis. Those derived from the vasa efferentia and other remnants of the Wolffian tubules are homologous with parovarian cysts in the female. (4) The vas aberrans of Haller, which is a diverticulum of, or a convoluted cæcal tube opening into, the vas deferens close to the lower end of the epididymis; this also is a part of the remains of one of the tubes of the Wolffian body still in connection with the representative of the excretory duct of that body,—namely, the vas deferens.

Cysts of the Testis.—These grow in front of the gland between the tunica albuginea of the testis and the testicular portion of the tunica vaginalis. They are usually of small size, and from intracystic tension feel like a hard body.

Symptoms of cysts of the epididymis and testis are slow in developing, though exceptionally, from traumatic rupture of a cyst into the cavity of the vaginal tunic, there may be swelling and pain characteristic of acute hydrocele. Small cysts, particularly those of the epididymis, are recognized with difficulty even by careful palpation. As they increase in size they form distinct fluctuating tumors, which, if the fluid is clear, transmit light. These cysts have often been mistaken for supernumerary testicles, or, because of tension and consequent hardness, for tuberculous infiltration of the epididymis. They seldom reach large size.

Diagnosis is founded upon translucency when the fluid contained in the cyst is limpid. Thrill, fluctuation, want of density and resistance, and slowness in development distinguish these cysts from sarcoceles. In shape they are globular when small, but if large and multilocular the shape varies greatly. By transmitted light the testicle is usually seen lying below and in front of the tumor, although it may be to one or the other side, more frequently the inner. On palpation it is often possible to determine that the enlargement is absolutely limited

to the upper portion of the testis and epididymis, and has a tendency to extend upward along the cord, the testis proper being perfectly normal and the tunica vaginalis containing no fluid. At times exploratory puncture with a hypodermic needle will be necessary before a diagnosis can be established. The fluid obtained will generally be found swarming with spermatozoa.

Treatment.—These cysts grow so slowly and cause so few symptoms that intervention is often not necessary. Evacuation by means of an aspirator or a small trocar and cannula may be followed by cure. If this fails, the scrotum may be opened and the cyst dissected out. The operation of excision is particularly indicated when the cysts are multiple or multilocular. When complete excision is impossible without extensively injuring the structure of the testis or epididymis, the cyst-wall should be removed as thoroughly as possible, and the remaining portion should be cauterized with carbolic acid.

HYDROCELE

" Hydrocele " indicates an abnormal amount of fluid about the testis or the cord, limited by the tunica vaginalis; without further qualifying words, as " encysted " or " of the cord," a serous effusion between the two layers of the tunica vaginalis testis is implied.

Prolongations of peritoneum, called the vaginal processes, precede the testicles in their descent into the scrotum, thus forming a pouch, into which the testicle with its epididymis is invaginated. The funicular portion of this pouch usually becomes obliterated from the internal abdominal ring to a point just above the testis, leaving a serous sac enveloping this organ, in which is normally found just enough fluid to allow its surfaces to glide smoothly over each other.

The invagination of the testicle into the peritoneal pouch necessarily forms a parietal and a visceral portion. The parietal portion forms a loose investment, extending above and below the testis, and connected by cellular tissue to the surrounding structures of the scrotum. The visceral portion invests the testis and the epididymis, connecting these structures, and forming a fossa or pouch between them (digital fossa). At the posterior portion of the gland it becomes continuous with the parietal layer. The tail and body of the epididymis are not included in the double serous envelope, since the reflection of the visceral layer is upon the front and sides of the scrotal ligament of the testicle, a fibro-muscular band passing from the lower posterior portion of the testis and the body of the epididymis to the dartos.

ACUTE HYDROCELE

This affection, an acute vaginalitis, is usually due to extension of acute inflammation from the epididymis. It may also be secondary to orchitis, and may be caused by traumatism.

It is probable that in every case of epididymitis there is some extension of inflammation to the tunica vaginalis, and that the acute effusions which complicate infectious disease or catheter urethritis are secondary to epididymitis or orchitis.

The pathological changes in the tunica vaginalis are essentially the same as

those occurring in acute inflammation of serous membranes in other parts of the body.

The effusion may be serous or fibrinous. Serous effusion, though common, is not often examined clinically, since it is slight, transitory, and indicative of a mild inflammation. Plastic effusion does not differ from ordinary inflammatory lymph. Suppuration is extremely rare.

Symptoms.—The symptoms of acute hydrocele are masked by those of the primary disease. . Thus, in gonorrhœal epididymitis the usually moderate amount of effusion into the vaginal tunic is obscured by the œdematous swelling of the entire scrotum. If effusion is abundant it will form a tense, rounded or pyriform, fluctuating tumor which is translucent and which feels like a greatly enlarged testicle.

The pain attending acute hydrocele is sometimes extremely severe, corresponding in type precisely to that of gonorrhœal epididymitis. This pain is doubtless due to tension, since puncture affords almost immediate relief. In addition to pain and swelling there are present heat, redness, and scrotal œdema. The general constitutional symptoms are, as a rule, slight.

Diagnosis.—The most important single diagnostic sign is translucency. This symptom is best elicited by looking through a tube not more than half an inch in diameter held against the scrotum toward a not too intense light held on the opposite side of the tumor. The test is most delicate when but a small area of the skin is illuminated. It may be performed with great satisfaction with the aid of two urethroscopic tubes, one of which is used to illuminate a small spot by pressing its end against the scrotal skin, while the second is used as a speculum. If the examination is performed in a darkened room and the light is guarded as suggested, frequently the examination tube may be dispensed with.

On the subsidence of acute inflammation the diagnosis can be made without difficulty by determining the presence of fluid. This test is made by seizing the scrotum in the left hand and making the skin over the swelling moderately tense. Then, by sudden pressure with the finger of the right hand, the sensation of liquid being pressed aside will be noted before the comparatively firm resistance of the testicle is felt; or by the alternate pressure of the two hands fluctuation may be detected. When inflammation has still further subsided, the presence or absence of fibrinous deposits may be determined by seizing the testicle in front and pressing it backward from between the thumb and fingers. Ordinarily it readily slips back, leaving in the grasp the scrotal tissue and the external layer of the vaginal tunic. If the parietal and visceral layers of the vaginal tunic are adherent, the testicle will not slip back from the grasp in this way, or, if it does, will leave a thickened mass between the thumb and fingers.

Examination of the subsidence of inflammation will generally show thickening and induration of the epididymis.

Prognosis.—Acute hydrocele undergoes, usually, resolution; the plastic deposit may organize partially or completely, obliterating the cavity of the tunica vaginalis; the inflammation may become chronic, constituting the ordinary form of hydrocele, and in this case organization of the fibrinous tissue often divides the general cavity into secondary ones, distinctly separated from one another; or, finally, suppuration may take place.

Treatment.—This is essentially that of the underlying condition, and therefore includes rest to the part, elevation, and evaporating lotions or counter-irritants. Pelvic congestion is to be avoided by regular and free evacuation of the bowel. If pain be a prominent symptom, aspiration should be promptly performed. In the latter stages the application of a pressure suspensory appears to be of advantage.

If the effusion is not absorbed in six weeks, treatment appropriate to chronic hydrocele is undertaken.

CHRONIC HYDROCELE

Jacobson thus classifies chronic hydrocele:

Hydrocele.

I. Of the testis.

(α) *Hydrocele of Tunica Vaginalis.* — The fluid is in a sac connected with that of the tunica vaginalis.

1. *Ordinary Hydrocele.*—The fluid distends the closed sac of the tunica vaginalis.
2. *Congenital Hydrocele.*—A communication exists between the cavity of the tunica vaginalis and that of the peritoneum.
3. *Infantile Hydrocele.*—The tunica vaginalis and the funicular process are distended with fluid, but these are shut off from the peritoneal cavity by an obliteration placed usually at the external ring.
4. *Inguinal Hydrocele.*—Hydrocele in relation with a retained testis.

(β) *Encysted Hydrocele.* —The fluid is in a sac distinct from that of the tunica vaginalis.

1. *Encysted Hydrocele of the Epididymis.*—The fluid is encysted in the neighborhood of the epididymis.
2. *Encysted Hydrocele of the Testis.*—The fluid is encysted between the tunica albuginea and the inner surface of the tunica vaginalis.

II. Of the cord.

(α) *Diffused.*—The fluid forms a serous collection of the nature of œdema in the cellular tissue of the cord.

(β) *Encysted.*—The fluid is contained in a distinct sac originating usually (1) in some unobliterated part of the processus funiculo-vaginalis; (2) in a cyst formed independently of this process,—*e.g.*, by dilatation of persistent tubules of the organ of Giraldès.

III. Complications of hydrocele.

(α) *With other Coexisting Hydroceles.—E.g.,* (1) hydrocele of the tunica vaginalis with encysted hydrocele of the testis; (2) hydrocele of the tunica vaginalis with encysted hydrocele of the cord; (3) hydrocele of the tunica vaginalis with diffused hydrocele of the cord.

(β) *With Hernia.—E.g.,* (1) hydrocele of the tunica vaginalis with inguinal hernia; (2) hydrocele of the cord with inguinal hernia.

IV. Hydrocele of the sac of a hernia.

HYDROCELE OF THE TUNICA VAGINALIS TESTIS

(Fig. 177.) This, the ordinary form of hydrocele, and most common in infancy and old age, is in the majority of cases secondary to pathological conditions of the epididymis, testicle, or cord. It is particularly associated with disease of the epididymis.

Loose cartilaginous bodies are sometimes, but rarely, found within the sac, and may by their continued irritation give rise to an abnormal secretion of fluid. Hydrocele may be due to passive exudation caused by an obstruction to the return of circulation. This exudation may be caused by an ill-fitting truss, by the presence of filariæ, or by hepatic or renal disease. The frequent occurrence of hydrocele in warm climates and in persons suffering from malaria

is due to associated hepatic enlargements. In general dropsy the scrotal tissues may be œdematous, but fluid in the tunica vaginalis is seldom or never found.

A certain number of cases seem to be idiopathic—*i.e.*, there is no discoverable preceding inflammation of the scrotal contents.

Chronic hydrocele may begin in the acute form, the effusion failing to be absorbed, and gradually increasing in quantity, or the onset may be insidious, the patient first detecting the condition by the increase in the size of the scrotum.

Jacobson holds that "in the great majority of cases the effusion of fluid commences passively, and without any irritation or inflammation to begin with, the causes predisposing to its production being the pendent position, the less

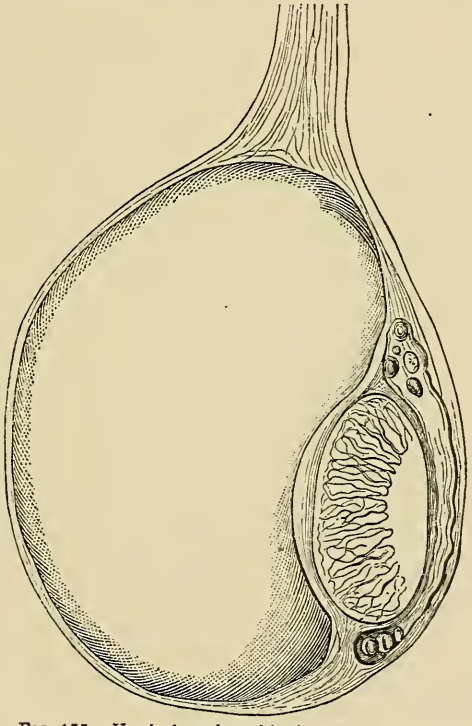


FIG. 177.—Vertical section of hydrocele. (Kocher.)

vigorous condition of the cremaster and dartos, feebler cardiac circulation, deficiency of tone in the scrotal blood-vessels and lymphatics, together with, perhaps, a tendency to venous congestion from hepatic and renal degeneration.

It is evident that from the etiological standpoint hydroceles may be classed as those developing primarily, and those secondary to traumatism, inflammation, or degeneration of the testicle, epididymis, or cord.

The fluid of chronic hydrocele is clear, yellowish, and much like that found in ascites. The specific gravity is about 1022, the reaction is neutral or slightly alkaline, and the fluid contains fibrin, albumin, and paraglobulin. The quantity of albumin (from four to six per cent.) found in the fluid strongly suggests the inflammatory origin of the affection.

In some cases cholesterin crystals are seen in the contents of a hydrocele, giving it a beautiful shimmering appearance. There is sometimes slight admixture of blood, the coloring-matter of which may be deposited in the form of blackish sediment. Tubercle bacilli have been found.

The average amount of fluid is from four to eight ounces. This produces a tumor of such dimensions that it becomes inconvenient, and the patient seeks surgical help. Some extraordinarily large accumulations have been observed, in one case more than six gallons.

Symptoms.—Chronic hydrocele, unlike the acute affection, is characterized by the absence of symptoms, the patient experiencing no inconvenience aside

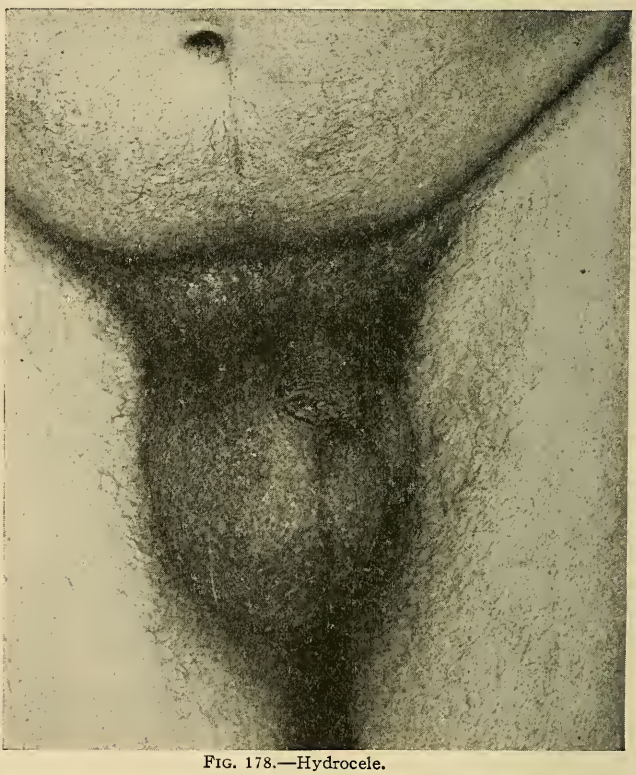


FIG. 178.—Hydrocele.

from the weight and size of the tumor. The rate of growth varies greatly. It may reach a large size in a few weeks, or may increase so slowly that a tumor of troublesome dimensions is not formed for years.

The tumor is usually smooth, tense, fluctuating, and pyriform, with the base below. It begins at the lower portion of the scrotum and grows upward. The veins of the scrotum and cord are not dilated in proportion to the size of the growth. The cord can usually be felt at the apex of the tumor; testicular pain, when elicited, gives information as to the position of this organ. The skin is smooth, and apparently normal. If the tumor is held in one hand and lightly percussed with one finger of the other, a vibrating thrill is felt which is char-

acteristic of fluctuation. When the swelling reaches large dimensions the penis is practically concealed in a fold of the skin. The tumor is dull on percussion, is heavy, and when pushed back between the legs springs forward again to its original position (Fig. 178).

Coincidently with the accumulation of fluid there is often chronic thickening of the vaginal tunic; this exceptionally undergoes cartilaginous or calcareous degeneration. Sometimes the visceral and parietal walls of the tunica vaginalis become adherent at points. Under these circumstances palpation may show certain indurated spots or distinct lobules.

It is important to know the position of the testicle in hydrocele, since otherwise it may be wounded in operations designed for cure. This gland usually lies in the mid-posterior portion of the tumor. Exceptionally, when there is inversion or when adhesions have formed, the testicle lies directly in front of the tumor and may be readily wounded, or it may lie at its lower pole (Fig. 179). The position of the testicle is determined by pressure. This, if suddenly exerted

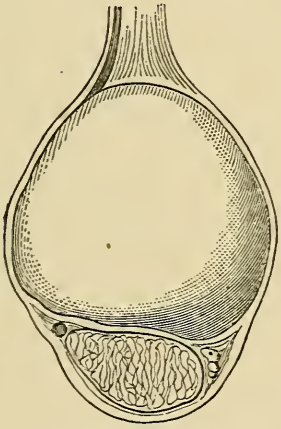


FIG. 179.—Vertical section of a hydrocele, showing the testicle lying below the cyst. (Kocher.)

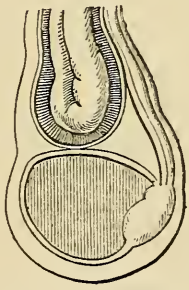


FIG. 180.—Inguinal hernia with hydrocele. (Kocher.)

by one or two fingers over various parts of the tumor, will produce the characteristic sickening pain when the testicle is reached. Transmitted light will better show the position of the testicle.

Diagnosis.—The diagnosis is based upon the development of a tumor in the lower part of the scrotum, its fluctuation, its pyriform shape, its projection forward, its translucency, and the small size of the cord. The light test should be conducted as described under acute hydrocele. This test will fail when the hydrocele contains a large quantity of cholesterin or when the fluid is turbid from blood, fat, or spermatozoa. Omental hernia may be slightly translucent, but the bright red glow so characteristic of ordinary hydrocele is never seen. When the fluctuation, transparency, and testicular sensation cannot be elicited, the diagnosis will depend upon the use of an aspirating needle, or, better than this, an incision, since thus can be made a thorough examination of both the testicle and the epididymis.

The differential diagnosis is to be made from hernias, neoplasms, other varieties of hydrocele, and hæmatocele.

The diagnosis from hernia, unless there exists incarceration or strangulation, with excessive exudation and without the typical abdominal symptoms, is usually not difficult. In hernia there are impulse upon coughing and percussion resonance; the tumor hangs directly down instead of protruding forward, grows smaller or disappears in the night, is reduced with a " flop," and in its development is first perceptible in the groin, then slowly reaches the scrotum; moreover it can be traced through its opening into the abdominal cavity. In none of these respects does it resemble hydrocele. In the ordinary hydrocele palpation shows that the inguinal canal is empty, fluctuation is readily elicited, and translucency is marked. These are all characteristics not found in hernia. When, however, a hydrocele becomes acutely inflamed from injury or other cause, and when the history of its formation is uncertain, diagnosis may be extremely difficult, and must be based mainly upon the absence of abdominal symptoms. Hernia and hydrocele may coexist; in this case the typical symptoms of each pathological condition may be elicited (Fig. 180).

From hæmatocele the more rapid growth of the swelling, the history of an injury or recent tapping, and the absence of thrill and translucency, will sometimes aid in the diagnosis, but when the tunic of the hydrocele is thickened or when its contents are opaque diagnosis is impossible.

These same conditions render the diagnosis from tumor difficult. Tumor, however, is heavier and denser than hydrocele, exhibits marked dilatation of the vessels of the cord and scrotum, and is attended by lymphatic enlargement (lumbar and sacral lymph nodes). In case of doubt, incision is indicated, since tumor in its comparatively early stages may be concealed by an accompanying hydrocele.

Prognosis.—Spontaneous cure is comparatively common in children. It hardly ever takes place in adults. So far as life is concerned, hydrocele is not dangerous, though it encourages the development of hernia, may lead to testicular atrophy, and occasionally suppurates. As a result of traumatism it may rupture into the tissues of the scrotum.

Treatment

The hydrocele of infants usually seems to be cured by the application of slightly stimulating lotions, such as ammonium muriate ten grains to the ounce of water, or an aqueous solution of ichthyol three per cent. The efficiency of these applications is questionable, and it is probable that when the effusion disappears this occurs spontaneously, practically uninfluenced by the local treatment. Cases which resist treatment by local applications should be tapped with a needle of moderate size (20 gauge), the removal of the fluid being followed by the injection of two or three minims of pure phenol. A week after such an injection any fluid present should be again removed.

The operative treatment may be palliative or curative.

PALLIATIVE TREATMENT consists in evacuation of the fluid contents of the hydrocele. In the chronic form of the disease there is almost reaccumulation, but this tapping may be repeated from time to time as the necessity for it is indicated by full distention.

The position of the testicle is first determined by means of the light test and by palpation, and the presence of hernia is carefully excluded. Exceptionally the gut becomes invaginated into the sac of a hydrocele, and might then readily be wounded by the trocar (Fig. 181). The patient lies either flat on his back or in a semi-recumbent position. The skin of the scrotum having been thoroughly disinfected, an exploratory puncture is made with a small hypodermic needle. The site of the proposed tapping is then infiltrated with novocaine and the skin punctured with tenotome, while the sac is made tense by seizing it from behind with the left hand. The trocar is plunged into the anterior part in an upward and backward direction, care being taken to avoid any superficial vein which may be apparent; the depth to which the trocar is plunged should be limited by keeping the thumb- or finger-nail in contact with the cannula (Fig. 182). By observing this precaution and by thrusting the trocar in the proper direction all danger of wounding the testicle is avoided, if its position has been before determined. When the sac has been emptied, the cannula is immediately withdrawn and the small opening is closed by a fragment of gauze held in place by collodion. In performing this operation it is important to have the trocar sharp and the cannula accurately fitted to it, as otherwise the sac will be pushed before the point of the instrument and will not be opened. Practically the only complication which can occur, save septic infection, is wounding of either the testicle or a large vein, with the effusion of blood into the hydrocele sac or the cellular substance of the scrotum. Elevation and pressure applied by the crossed of the perineum bandage or with

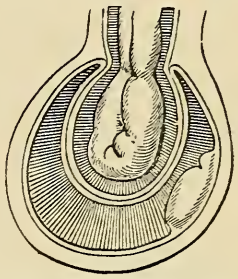


FIG. 181.—Inguinal hernia invaginating the upper portion of the sac of a hydrocele (Kocher).

FIG. 182.—Tapping a hydrocele.

a well-fitting jock-strap are usually sufficient to check this bleeding. After a tapping there is no need to limit the patient's activities unless they be such as to imply violent muscular effort.

CURATIVE TREATMENT.—Under this heading are included the various cutting operations, having for their purpose the obliteration of the sac.

Excision.—Excision of the parietal layer of the tunica vaginalis is indicated when the membrane is greatly thickened. It is performed by dissecting this tunic from the tissues of the scrotum and cutting it away.

The field of operation is prepared in accordance with general surgical principles. The sac is made tense by an assistant, and under local or general anæsthesia the scrotal covering is divided by a vertical cut running from the top to the bottom of the tumor. After complete hæmostasis the vaginal tunic is incised sufficiently to admit a finger, and the condition and position of the testicle are clearly defined. The remainder of the sac is then split up with a blunt pair of scissors, and the tunica vaginalis is dissected from the scrotum. This can usually be accomplished by sponging and an occasional push-cut with the knife. The bleeding points should be picked up with hæmostatic forceps, which should be left on until the operation is completed. When the parietal layer has been dissected free it should be cut away from the testicle and epididymis as closely as possible. Cysts or fibrous bodies attached to the visceral

FIG. 183.—First step in operation for hydrocele. Scrotal coverings incised down to glistening wall of sac.

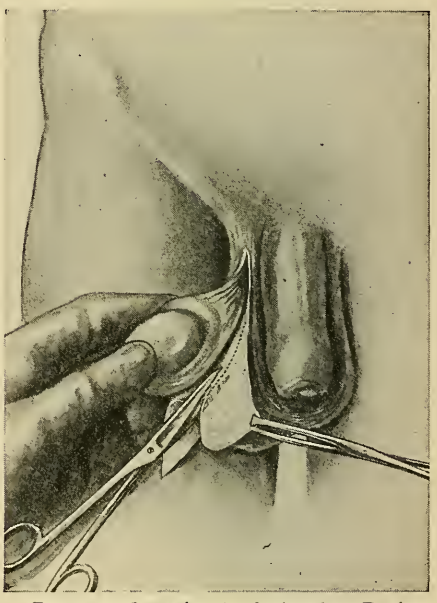


FIG. 184.—Operation for hydrocele. Testicle everted and redundant edges of sac being cut away.

portion of the sac should be removed. The wound should be closed without drainage if hæmostasis be complete and the skin suture accurate, a properly fitting jock-strap over a sterile dressing will enable the patient to resume immediately his usual vocation.

The external dressing should be antiseptic and compressing (crossed of the perineum). Sutures are removed on the third to the fifth day.

Eversion of the Sac.—The most used method consists in incising the scrotum down to the serous layer of the sac for a sufficient distance to deliver the cyst, freeing it from the surrounding tissues, incising it along its anterior surface, and, finally suturing the cut edges to one another behind the testicle (Fig. 183), usually a portion of the sac can be resected with advantage, only enough being left to allow for easy suturing behind the epididymis (Fig. 184).

Hemorrhage should be guarded against by the clamping of even the smallest vessels, preferably before they are divided, as they show a strong tendency to retract. When all bleeding has been stopped, the testicle is returned to the scrotum, and the skin wound is sutured.

The purpose of this operation is the contacting of the serous surface with connective tissue, that there may be no serous sac in which serum may collect.

Infantile Hydrocele

This is an effusion into a sac formed by more or less of the unobliterated funicular portion of the vaginal tunic. This sac is closed from the peritoneal cavity above, and communicates with the tunica vaginalis testis below.

Symptoms.—The symptoms are those of hydrocele extending well up along the cord. The tumor shows no change in tension on recumbency.

Treatment.—Simple evacuation with the finest needle of the aspirator may be followed by cure, since there is a natural tendency towards obliteration of the sac on evacuation of its contents.

Should this be unsuccessful, the sac should be in part or completely excised.

Bilocular Hydrocele

Exceptionally the scrotal hydrocele is bilocular,—that is, there are two distinct cavities filled with fluid and communicating with each other by a

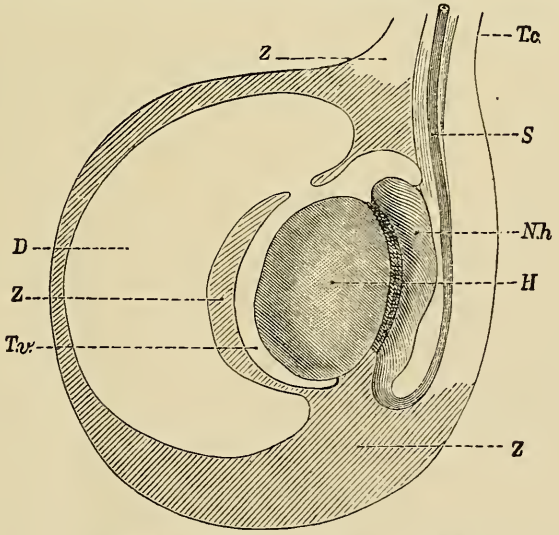


FIG. 185.—Bilocular hydrocele. (Béraud.) *H*, testicle; *N.h*, epididymis; *S*, vas; *T.v*, cavity of the tunica vaginalis; *D*, cavity of the diverticulum; *T.c*, tunica vaginalis communis; *Z*, cellular tissue between the tunica propria and the tunica communis. (Kocher.)

comparatively narrow opening. One variety of this bilocular formation is described by Curling as due to the distention of the visceral portion of the vaginal tunic passing between the body of the testis and the epididymis. Normally, in this position there is a pouch, which, under tension, may extend, forming a

tumor, to the inner side of the testis; the opening into this accumulation is from the outer side. Béraud has described two cases of diverticular development (Fig. 185) due to the lessened resistance of a certain portion of the parietal vaginal tunic, which, yielding to the pressure of effusion, forms a distinct pouch.

There is a perineal form of bilocular hydrocele dependent upon trauma, causing rupture of a preëxisting hydrocele and an effusion of the contents into the perineum. This effusion becomes encapsulated. These bilocular hydroceles are usually translucent. They may be shown by alternate pressure to communicate with each other.

Another comparatively rare form of bilocular hydrocele—a variation of the infantile type—occurs as follows: The funicular portion of the tunica vaginalis is commonly obliterated at the internal ring. Below this the whole tunica vaginalis may be patulous, or it may be closed just above the position of the testis. As the fluid accumulates, sacculation develops, the tumor extending either backward and downward into the pelvis, or more commonly upward and inward between the abdominal muscles and the peritoneum.

Symptoms.—In addition to the ordinary symptoms of hydrocele (*i.e.*, fluctuation, dulness on percussion, translucency, and smooth surface) there will be found a constriction separating the tumor into two portions. Alternate pressure will show that these portions intercommunicate, and exceptionally, when tension is not great, the opening of communication may be distinctly felt. It is usually placed at the external ring. The scrotal tumor is smaller than that formed in the abdominal parietes. There is distinct impulse on coughing.

Treatment.—Bilocular hydrocele is best treated by incision, with removal of the sac, or as much of it as is accessible. Care should be taken to avoid opening the general peritoneal cavity.

Multilocular Hydrocele

Multilocular hydrocele of the testicle may be hereditary or may be due to inflammatory adhesions, which, by causing agglutination between the folds of the vaginal tunic, but without obliterating it, leave a number of cavities into which serum can be exuded. On palpation the tumor will be found somewhat irregular in outline, and aspiration will evacuate only a small portion of its contents, not materially diminishing the tension of the rest of the tumor.

Treatment.—This consists in the excision of the sacs. When excision is impracticable, the cysts may be opened and their interiors painted with phenol.

Inguinal Hydrocele

The hydrocele which forms in the vaginal tunic of the undescended testicle may be of the ordinary variety or may be congenital, communication persisting between the vaginal tunic and the general peritoneal cavity. We have seen it distinctly bilocular, one pouch passing upward for three inches between the peritoneum and the transversalis fascia, the second pouch extending through the external ring and forming a tumor in the scrotum.

Symptoms.—The symptoms are those already given as characteristic of hydrocele, except that the tumor is formed in the inguinal region.

Treatment.—Since it is very difficult to exclude the presence of hernia,

inguinal hydrocele should be treated by open incision, the sac being partly or completely removed. Healthy testicles should be brought down into the scrotum; when marked wasting exists the appropriate operation is castration.

Fatty Hydrocele

This has been variously described as chylous or milky hydrocele, and is the name given to a collection of fluid resembling milk or chyle in the tunica vaginalis testis. It may be produced by lymphorrhagia following an actual rupture of the lymphatic channels or by leakage of lymph through the walls of the vessels. This latter method is the more common, and is dependent upon obstruction to the return of the lymph, either by an inflammatory process or by the presence of filariæ.

It has been maintained that the presence of fat is due to degenerative changes occurring in a simple hydrocele. Whatever the causation, the density of the contained fluid renders diagnosis difficult, since translucency is lacking. The other symptoms of hydrocele are present. If the effusion is double and the patient is an inhabitant of a tropical climate, an examination for filariæ should be made.

Treatment.—Excision of the sac is indicated.

Congenital Hydrocele

This form of hydrocele depends for its existence upon the maintenance of a communication between the tunica vaginalis and the abdominal cavity. The funicular portion of the tunic does not become obliterated. The fluid may come from the general abdominal cavity or may be exuded from the vaginal tunic. It may develop in early infancy or not until later life.

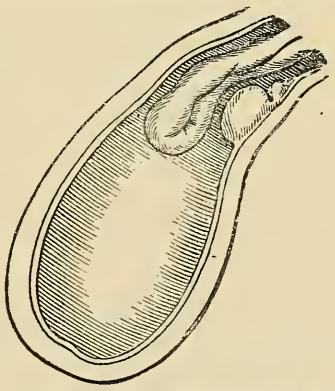


Fig. 186.—Congenital hydrocele with hernia.

Symptoms.—The general appearance is that of a hydrocele of small size, which extends up the cord into the inguinal canal. It is generally stated by the patient that the tumor becomes smaller or disappears entirely during the night, yet attempts on the part of the physician to expel the fluid into the abdominal cavity are frequently futile. When reduction can be effected, pressure over the inguinal canal fails to prevent the reappearance of the tumor after the patient has assumed the upright position. Impulse on coughing may or may not be present (Fig. 186).

Diagnosis.—Hernia is the only condition with which congenital hydrocele is likely to be confused. The diagnosis is based on the greater translucency of the latter, the dull note obtained on percussion, and the manner in which reduction, when this is possible, is accomplished, this being slow and gradual, usually with some difficulty, and unaccompanied by the characteristic "flop." The gradual reappearance of the swelling, in spite of gentle pressure on the canal by finger or truss, also differentiates hydrocele from hernia.

Prognosis.—This is good, as these hydroceles commonly disappear spontaneously with obliteration of the funicular portion of the vaginal tunic.

Treatment.—The obliteration of the vaginal tunic is favored by the application of a truss, which may be required for the treatment of the coexistent hernia. In case the truss is not successful, an operation for the radical cure of inguinal hernia should be performed, with ligation of the sac above the testicle so as to form a tunica vaginalis.

HYDROCELE OF THE CORD

Acute Hydrocele of the Cord.—This is a rare condition, seen most frequently in young subjects after strain. A translucent swelling forms, containing fluid resembling that of ordinary hydrocele. The effusion is limited by the investment of the cord, and is rather an acute œdema into loose cellular tissue than an effusion of fluid into a sac.

Mollière holds that this acute œdema is due to rheumatismal funiculitis. The affection develops with local inflammatory phenomena, but without much pain.

It may simulate an incarcerated hernia, but may be distinguished by its translucency, and by dulness on percussion and absence of abdominal symptoms. The swelling may involve the entire cord, transforming it into a soft sausage-shaped mass.

Treatment.—Compresses wet in lead water and alcohol and held in place by a crossed of the perineum gauze bandage will limit the swelling and hasten its subsidence.

Diffuse Hydrocele of the Cord.—This is a general infiltration into the cellular tissue enclosed by the fascia which invests the cord. The tunica vaginalis is not affected; indeed, the funicular portion of this tunic is usually completely obliterated. The etiology is obscure, but is probably dependent on passive exudation from the veins and lymphatics of the cord due to pressure interference with return circulation. It is not associated with general œdema of the penis and scrotum, since the fibrous tunic of the cord entirely separates this structure from the cellular tissue lying beneath the deep layer of the superficial fascia.

Symptoms.—The tumor forms gradually, with very few symptoms. It may involve the entire length of the cord, reaching from the testicle to the internal ring and filling the inguinal canal. It is broader in its lower portion, and may cover the upper portion of the testis and epididymis as a cap. On placing the patient on his back and elevating the testicle the swelling gradually diminishes, but does not disappear entirely. On gentle continued pressure deep pitting may be detected. The infiltration is painless unless it be a sequel of acute inflammation, is doughy rather than fluctuating, and gives the test of translucency.

The differential diagnosis must be made from omental hernia. This gives a more distinct impulse on coughing, is not so smooth, can be reduced suddenly and completely, and is very feebly translucent. In irreducible omental hernias of fat people a preoperative diagnosis may be impossible.

Treatment.—When the infiltration produces a tumor of such size as to cause inconvenience from its bulk, incision and drainage are indicated.

Encysted hydrocele of the cord, or funicular hydrocele, consists of an accumulation of fluid within an unobliterated portion of the funicular portion of the tunica vaginalis. This accumulation is closed from the peritoneal cavity above and from the tunica vaginalis testis below. In many cases swellings apparently belonging in this class, on account of the difficulty attending their reduction, in reality communicate with the abdominal cavity, and are therefore of the congenital type. The hydrocele may be unilocular, bilocular, or multilocular, in the latter case forming a series of small cysts along the course of the cord. These cysts may be placed in the inguinal canal, and are more common on the right side. They are usually observed in children, and may be complicated by hernia (Fig. 187).

Symptoms.—A smooth, dense, ovoid, fluctuating swelling is formed in some portion of the spermatic cord. By transmitted light the tumor is found to be translucent, and the testicle can usually be recognized below it.

Diagnosis.—This is based on the position of the cyst or cysts. Encysted hydrocele of the testicle, though sometimes extending upward along the cord, is attached to the testis and the epididymis. In hydrocele of the cord palpation will show that the tumor is not directly connected with the testicle. Hydrocele of the cord is distinguished from hernia by absence of impulse on coughing, inability to reduce the tumor entirely within the abdominal cavity, though it is often easily pressed back into the inguinal canal, and absence of tympany and gurgling. The hernia is not translucent.

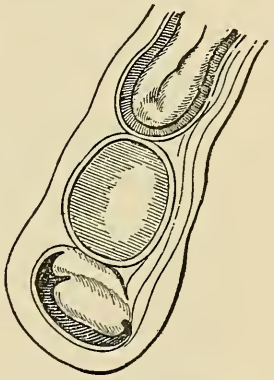


Fig. 187.—Inguinal hernia, with hydrocele of the cord. (Kocher.)

Treatment.—In children spontaneous cure may occur. Excision of the sac is probably the safest method of treatment, and the one most certain to effect a cure. In elderly people, where radical measures are not desired, repeated tappings will be necessary to afford relief.

HYDROCELE INTO A HERNIAL SAC

An effusion of serum which may closely simulate hydrocele may take place into the sac of an inguinal or a scrotal hernia. This sac may contain only fluid, or it may contain in addition to the fluid a portion of gut or omentum, the hernia being incarcerated. There is always more or less effusion in combination with incarcerated hernia, and the sac not infrequently becomes thickened and fibrous, closely resembling the investment of chronic hydrocele or a hæmatocele. The symptoms are those of a hernia followed by the development of a fluctuating, probably translucent tumor. When the sac contains both fluid and intestinal contents, tenderness and possibly resonance in the inguinal region may lead to a correct diagnosis. Frequently the diagnosis is made only after incision.

Treatment.—Excision of the sac and an operation for the radical cure of the hernia constitute the only practical treatment.

HÆMATOCELE

Hæmatocele is a collection of blood or bloody fluid in the vaginal tunic of the testicle or cord or in the substance of either of these structures. As is the case with hydrocele, the effusion may be acute or chronic.

Acute Hæmatocele of the Tunica Vaginalis

This affection as compared with hydrocele is rare. It may develop as a result of punctured wound or rupture of the testis, or may be caused by a blow or by violent muscular strain. Svalin noted blood effusion into the tunica vaginalis and the scrotal tissues after severe coughing. There may be bleeding into a previously healthy tunica vaginalis; commonly it is into a previously inflamed sac, and often it occurs as a complication of hydrocele. It may be complicated by scrotal hæmatoma.

The development of acute hæmatocele (hæmatoma) is characterized by severe pain, which may be sickening in character, and the rapid formation of a tumor.

This tumor completely envelops the testicle, and closely corresponds to it in shape.

The blood may coagulate or remain fluid. The tumor never reaches large dimensions, since it forms so rapidly that the tunica vaginalis ruptures, thus allowing the blood to escape into the scrotal tissues.

Symptoms.—The distention of the vaginal tunic is usually obscured by the concomitant scrotal blood effusion. After this has been absorbed there may be found a fluctuating tumor impervious to light and giving on exploratory puncture blood or blood-stained fluid.

Exceptionally complete resolution takes place. Usually the tunica vaginalis undergoes the alterations characteristic of chronic hydrocele.

Treatment.—Acute hæmatocele incident to trauma is treated by rest, elevation of the parts, and the application of evaporating lotions or the ice-bag. If the swelling is rapid and progressive, clots should be evacuated through an incision, and a search made for the bleeding vessel. The scrotal infiltration is quickly absorbed. If on its disappearance the vaginal tunic is still distended, its contents should be evacuated through a free incision, since otherwise the tunica vaginalis becomes chronically inflamed and a chronic hæmatocele may form.

Chronic Hæmatocele of the Tunica Vaginalis

This affection is dependent upon chronic inflammation of the tunica vaginalis, and is properly called peri-orchitis hæmorrhagica or hæmorrhagic vaginalitis. The blood effusion is simply a symptom of such inflammation, which, in turn, is generally regarded as secondary to disease of the epididymis or of the testis.

Gosselin recognizes three degrees of hæmatocele, basing his classification upon the extent of lesion which the walls of the sac show. The first degree is characterized by moderate thickening, the vaginal tunic being but little altered beyond some increase in vascularity. There is a deposit of thin, nonadherent false membrane. On evacuation of its contents the sac will collapse. The second degree is characterized by increased thickness of both the vaginal tunic

and the false membranes, the walls being too rigid to collapse on evacuation of the contents of the sac. The condition is progressive.

The third degree is characterized by still greater thickening and rigidity. Areas of cartilaginous and calcareous transformation are observed. Barigandin described a case of ossification of the tunica vaginalis. In the thickened walls are often found foci of soft granulation-tissue or interstitial hemorrhages.

The thickened sac is made up partly of fibrinous deposits and partly by organization of the infiltrate into the subserous connective tissue (Fig. 188).

On incising a hæmatocele blood more or less altered or blood mingled with

FIG. 188.—Sac of chronic hæmatocele. Observe the thickened, non-collapsible character of the sac. Adherent to the interior are fibrinous deposits and blood coagula.

hydrocele fluid is found. In old cases the blood is altered both in color and in consistence, and may form a chocolate-colored or black syrupy, or even a gelatinous mass. When the bleeding is into the sac of a hydrocele the fluid is clear red and contains clots.

In recent cases (*i.e.*, those in which the sac is not greatly thickened) the testicle may not be appreciably altered, even though the tumor is of great size. As induration and thickening, in consequence of subserous infiltration and organization, take place, the albuginea becomes involved, together with its fibrous trabeculæ, and there results an atrophy of the tubules with fatty degeneration of their epithelium. In the large, greatly thickened, degenerated sacs careful search may fail to discover even a trace of the testis.

The testicle usually lies in the lower posterior portion of the tumor. In

the early stages of development, before the gland has atrophied, palpation, eliciting testicular sensation, will probably enable the surgeon to determine its exact position. In the late stages of hæmatocele where the sac is greatly thickened it may be impossible to determine whether the testicle lies in front of or behind the swelling. In such a case operation should be conducted with great care, the tissues being examined before they are cut.

Chronic hæmatocele is of slow formation, and is most common between the fortieth and the sixtieth years of age. It may grow steadily, or may rapidly increase in size after brief intervals of quiescence. The tumor is hard, painless, ovoid or pyriform in shape, with smooth or bosselated surface, showing at times spots of softening and possibly dense areas of calcareous degeneration.

Diagnosis.—This is founded on the smooth bossed surface, the rounded or oval shape, the tense, elastic feel, the varying consistence, and the absence in any portion of the tumor of either a projection or a depression corresponding to the position of the testicle or the epididymis. There is usually a history of traumatism, strain, or preëxisting hydrocele. The general growth of the tumor is slow, but it exhibits irregularly recurring periods of rapid increase in size, attended by pain, heat, and swelling. These sudden increments are due to fresh hemorrhages into the sac. The tumor is not translucent. The final diagnosis depends upon aspiration. For the purpose of thus confirming the diagnosis a needle longer than that employed in the ordinary hypodermic syringe is required.

The distinction from hydrocele is dependent upon absence of distinct thrill and fluctuation, failure to detect translucency, and finally the result of exploratory tapping or incision. Diagnosis from chronic orchitis or malignant growths may be absolutely impossible, except from the history. In case of doubt there should be no hesitation in deciding the matter by an aseptic incision.

Prognosis.—There is no tendency towards spontaneous cure. The disease may, however, become self-limited. It usually progresses, forming ultimately a large tumor, which inconveniences mainly by its bulk and by the pain and disability dependent upon the intercurrent attacks of acute inflammation. Even though the patient experiences no mechanical inconveniences from the growth, it inevitably destroys the secreting function of the testicle and predisposes to suppuration and to malignant degeneration. Suppuration may follow the use of an apparently clean trocar, since the conditions are exceedingly favorable to germ-growth. At times it occurs from hæmatogenous infection, the predisposing cause being trauma. The hæmatocele and the scrotum of the affected side become œdematous and painful, the symptoms of constitutional infection develop, and softening takes place, followed by grumous discharge. Some cases of malignant degeneration of hæmatocele have been recorded. It is probable, however, that in these the hæmatocele complicated cancer and developed secondarily.

Treatment.—Chronic hæmatocele should be treated by excision of the sac, together with its thick lining or pseudomembrane. The wound should be closed without drainage.

Incision followed by curetting is the simplest and most easily performed of the radical operations, and is successful when the walls of the sac have not

become extensively infiltrated and rigid. The cavity of the cyst is opened by a free incision, which, unless the position of the testicle has been determined previously, is deepened with the utmost care. The contents of the sac are washed out, and the whole interior is scraped smooth with a sharp curette. So much of the outer wall of the vaginal tunic as can be easily freed is cut away, and the remaining portion is sewed to the skin. The cavity is then loosely packed with iodoform gauze, and is allowed to heal by granulation.

When, because of great thickening and rigidity, with cartilaginous or calcareous deposits, it is evidently impossible for the walls of the sac to come together and become obliterated, or even to produce healthy granulations, decortication is indicated. This is practised by opening the tunica vaginalis and tearing and dissecting away from it the thick layers of false membrane by means of the finger or by rough sponging; more often the knife or scissors are required. When the false membrane has been reflected as closely as possible to the testis and cord without wounding these structures, it is cut away, the edges of the vaginal tunic are sutured to the skin, and the wound is lightly packed.

Castration is indicated in long-standing hæmatoceles in old subjects when there is reason to believe that the testicle is partially or completely atrophied and the patient is not in a condition to stand a prolonged operation.

Encysted Hæmatocele of the Testis

This is an extravasation of blood into an encysted hydrocele. The symptoms are those of sudden increase of a preëxisting encysted hydrocele, with inflammatory phenomena. The tumor fluctuates at first, but is not translucent.

Treatment.—Total excision of the sac is indicated

Intratesticular Hæmatocele

This results from traumatism. After an injury persistent pain and swelling not dependent on hydrocele might suggest parenchymatous effusion of blood, though, except by puncture, an early diagnosis from acute orchitis would be impossible. The pain of these hæmatomata is said to be extremely severe and persistent. The detection of a fluctuating area in the testicle proper would indicate incision and drainage.

Parenchymatous hæmatocele of the epididymis is reported by Jacobson.

Treatment.—If, following testicular trauma properly treated (see p. 313), pain remains intense and persistent, the testicle showing a moderate increase in size not dependent upon hydrocele, exploratory puncture of this gland with the finest needle of the aspirator is indicated, since these symptoms may be due to a hæmatoma, which, if allowed to remain, may produce total disorganization of the testicle. The aspirating needle should be thrust in at the most painful spot or into any area of obscure softening or fluctuation, if this can be detected. If the needle shows that there is an encysted blood effusion, this should be opened, the blood evacuated, and the cavity drained.

Hæmatocele of the Cord

This may be diffuse or encysted.

Diffuse hæmatocele is usually due to rupture of a vein from direct traumatism or sudden increase of intraabdominal pressure. There forms quickly

a doughy, sausage-shaped tumor, occupying the position of the cord, and entirely obscuring it. This tumor is not translucent.

In the chronic form of diffuse hæmatocele of the cord the blood effusion may reach enormous dimensions. It is characterized by great thickening of the limiting walls.

Treatment.—This has for its object the limitation of effusion and the prevention of inflammatory reaction. The patient is put to bed. A layer of cotton is placed over the cord, and a crossed of the perineum bandage is firmly applied. If in twenty-four hours it is evident that the bleeding has ceased, inflammatory reaction is limited by evaporating lotions or the ice-bag. Should bleeding persist in spite of pressure, incision, securing the bleeding point, and closure of the wound without drainage are indicated.

Encysted hæmatocele of the cord is due to hemorrhage into an encysted hydrocele or to the encysting of a hemorrhage into the cord. It begins in the lower part of the cord, forming a pyriform tumor, with the base down, which ultimately may become merged with the epididymis and testis.

The diagnosis is suggested by the history of the tumor, especially its origin, and the absence of translucency.

Treatment.—Incision, evacuation of clots, and decortication or complete removal of the sac are indicated.

LOOSE BODIES IN THE TUNICA VAGINALIS

It sometimes happens that on palpation of the testis a rather hard body, about the size of a kidney-bean or smaller than this, may be felt moving freely under the finger. This body is smooth and elastic; its motion may be limited, or may be so free that the body can be pushed into any portion of the vaginal sac. There is usually a moderate degree of hydrocele of a thickish consistence. These bodies are often cysts with thick walls, sometimes exhibiting calcareous degeneration, the remains of fœtal structures; they originate beneath the tunica vaginalis, and become pedunculated and finally free, the pedicle rupturing. Floating fibroid and cartilaginous bodies are also found; these grow from the subserous connective tissue and later become detached and lie loose in the cavity. They are generally small and multiple.

Symptoms.—These bodies are commonly found accidentally, and cause no symptoms beyond a moderate hydrocele. If they cause pain and acute vaginalitis, or if they are encountered during the radical cure of hydrocele, they should be removed.

NEURALGIA OF THE TESTICLES

Reference has been made already to the intense pain which accompanies inflammatory conditions of the testicle and epididymis. There may, however, be a pain equally severe which occurs without apparent cause in testicles showing no evidence of disease. This pain may be in the testicle or may shoot from this region along the cord. It may be continuous, or regularly or irregularly intermittent. It is symptomatic of what Cooper called "irritable testicle," and is sometimes observed in hysterical patients. Exceptionally the aura of true epilepsy takes the form of neuralgia of the testis.

Many cases supposed to be purely neuralgic are dependent upon distinct lesion. Thus, the pain may be excited by tumors, such as fibromata or myomata, or by parenchymatous blood-cysts, or by the congestions incident to varicocele.

The only symptom of the neuralgia is pain. This may be agonizing in its intensity, and may be associated with tonic or clonic spasm of the cremaster muscle. The testicle is extremely sensitive, even friction of the garments or the slightest touch causing severe suffering. During the paroxysms of pain the testicle may become hard and the vessels of the cord congested. The neuralgia may be dependent upon traces of a previous inflammation, the presence of a hernia, or certain systemic conditions, as gout, rheumatism, or toxæmia. We believe that careful examination will show that the majority of cases are in part due to a varicose condition of the spermatic veins. It is true that varicocele may attain enormous dimensions and yet cause no pain. Even slight dilatation may, however, occasion marked symptoms in those who are hereditarily neurotic. Cases which are unaccompanied by tenderness of the gland are often due to seminal vesiculitis or prostatitis. Errors in sexual hygiene, especially long periods of ungratified sexual excitement, are frequently at the basis of the condition.

Treatment.—The first thought, in treating this affection, should be to exclude organic lesions, such as blood-cyst, tubercle, hernia, varicocele, seminal vesiculitis, and prostatitis; when it is evident that pain is not dependent upon a local condition which may be remedied by operation, palliative treatment is indicated. A great number of external applications and internal remedies have been used, and often successfully. It must be confessed that certain cases resist every form of treatment. Among the most serviceable therapeutic measures are the pressure suspensory bandage, local applications of heat and cold, counter-irritation, freezing the overlying skin with ethyl chloride, blisters, galvanism, and the ice-bag. Internally there may be given aconitine in full doses, quinine, antipyrin, acetanilid, valerian, and hyoscine. The general treatment should be hygienic and, if indicated, anti-rheumatic.

CHAPTER XVI
SURGERY OF THE SPERMATIC CORD

ANATOMY

The spermatic cord is about four inches in length, and extends from the internal abdominal ring to the globus minor of the epididymis. It is made up of the vas deferens, or excretory duct of the testicle, the spermatic artery from the aorta, the artery of the vas deferens from the inferior vesical, the cremasteric artery from the deep epigastric, the spermatic veins, the spermatic nerve, plexus, branches of the ilioinguinal and genitocrural nerves, and lymphatics. These structures are bound together by loose fibrous tissue, and are invested by the fasciæ carried down by the testicle in its descent. The vas deferens lies below and behind the larger anterior group of veins and the spermatic artery. The veins of the cord called the pampiniform plexus unite into a single trunk, on the right side passing into the inferior vena cava and on the left side into the left renal vein. The artery of the vas is in direct relation with it, while the spermatic artery follows a tortuous course throughout the cord. The nerves are distributed throughout the cord, with the exception of filaments from the hypogastric plexus, which invest the vas in a rich net-work. The four to eight lymphatic vessels empty into the glands surrounding the lower part of the aorta, and one gland lying over the external iliac artery.

Attention has been called to certain anomalies of the cord. Thus, this structure may be absent, even though the testicle is in its normal place, or the two cords may be fused, or one cord may be double. The vas may communicate directly with the ureter, as is normal at one period in fœtal life, or may be entirely wanting in its prostatic portion, or the two vasa may be fused. The single duct may open into the utricle, or may continue by a distinct passage to the glans penis.

CONTUSIONS AND WOUNDS OF THE CORD

Contusions rarely cause injury other than an acute hæmatocele, the blood which is poured out from the ruptured veins being limited by the fibrous sheath of the cord, thus forming a sausage-shaped tumor which may extend from the testicle to the internal ring, filling the inguinal canal. It is usually associated with hemorrhage into the scrotal tissue, which may completely mask it.

Treatment.—Rest, elevation, pressure, and the application of ice during the bleeding stage, followed by evaporating liniments, and possibly massage for the purpose of hastening absorption, outline the treatment.

Wounds of the cord are necessarily attended by free bleeding, for the arrest of which ligatures are required. If the deferent canal is divided, its continuity may be restored by suture. Division of the vas is not followed by atrophy of the testicle, even though the operation for the restoration of the continuity of the canal is not performed. When the spermatic artery is divided, and particularly when the plexus of nerves supplying the testicle is extensively injured, atrophy or gangrene is extremely likely to result.

INFLAMMATION OF THE CORD

Funiculitis or inflammation of the cord may be acute or chronic.

Acute funiculitis may arise from extension of a posterior urethritis along the vas (Fig. 189), or from phlebitis, especially that dependent upon rheumatism. Two forms of the affection have been described, serous and phlegmonous. It is possible that serous funiculitis (diffuse hydrocele), which forms a rounded, sausage-shaped, pitting, translucent tumor occupying the position of the cord, is in reality sometimes an encysted hydrocele. It occurs as a complication of gonorrhœa.

Fig. 189.—Acute gonorrhœal funiculitis.

Phlegmonous funiculitis is usually traumatic in origin. It is also caused by gonorrhœal inflammation of the vas and by septic phlebitis. The sausage-shaped tumor is extremely tender, and may develop with symptoms characteristic of strangulated hernia. Should the infiltrate suppurate, it is likely to invade the peritoneal cavity in its upward extension.

Chronic funiculitis is usually tuberculous. In the course of genito-urinary tuberculosis the vas is frequently infiltrated. This is nearly always secondary to involvement of the epididymis or the prostate. Exceptionally nodules first develop in the vas, the epididymis being apparently healthy. Reclus has observed two such cases; in one the nodules involved the cord at the position of the external ring, in the other it was within the inguinal canal.

In the rare cases of primary involvement of the vas the appropriate treatment is excision of the affected portion of the canal, followed by anastomosis.

Treatment.—Acute funiculitis is treated by rest, elevation, and the application of cold, preferably in the form of evaporating lotions. Should the swelling be so marked as to threaten the vitality of the testis, incision and drainage are indicated.

TUMORS OF THE CORD

Tumors of the cord may be either cystic or solid.

The cystic tumors may be diffuse or encysted, and include hydrocele, hæmatocele, spermatocele, etc. (see p. 356).

The solid tumors include lipoma, fibroma, fibro-lipoma, myoma, myxoma, sarcoma, and carcinoma.

Lipoma is the most frequent solid tumor of the cord. It may develop entirely in the scrotal portion of this structure, or may extend along the inguinal canal and into the pelvis. Lipoma may reach a large size; Wilms reports one which

weighed twenty pounds. In the course of its growth the lipoma incidentally becomes distinctly lobulated, simulating malignant disease, penetrating between the structures of the cord (Fig. 190), and making entire removal without sacrifice of the testicle impossible; hence the importance of early treatment.

Lipoma may undergo myxoid degeneration, and exhibit a tendency to recur on removal.

The symptoms are those of a painless, slow, somewhat irregular, slightly translucent, soft but lobulated growth in the course of the cord.

FIG. 190.—Lipoma of the cord.

The diagnosis from omental hernia may be impossible without exploratory incision. Even then the surgeon may be in doubt, but may be guided by remembering that the fatty growth of an epiplocele is within the peritoneal sac and is often adherent to it. The history of lipoma differs from that of hernia, since it gradually develops along the course of the cord, grows upward, is not reducible, and until it involves the inguinal canal will not give an impulse on coughing.

Treatment.—Early excision is always indicated, since when the tumor is small it may be entirely removed without sacrificing the cord. When the tumor has reached a large size and it is impossible to dissect it free from the structures of the cord, castration is indicated.

FIBROMA, FIBRO-LIPOMA, AND MYOMA occur rarely. The diagnosis is usually not made till after removal of the growth. The treatment is excision.

MYXOMA is rare. It may be found together with lipoma, giving a semi-malignant character to an otherwise benign tumor.

SARCOMA AND CARCINOMA are more frequent than myxoma. They both cause metastasis and develop as do similar tumors in other regions of the body. They often undergo cystic degeneration.

The treatment is castration, with removal of as much of the cord as possible.

VARICOCELE

Dilatation and elongation of the veins of the spermatic cord (Fig. 191) is most frequent in early manhood—that is, from about the fifteenth to the twenty-fifth year; it is rare in infancy; in old age it is of moderate development and causes little inconvenience. The veins of the cord are especially prone to dila-

tation and elongation from the fact that their valves are insufficient, and hence there is a long column of blood to be supported. The disease usually affects the left testicle (ninety per cent. of cases), possibly because the vein, instead of passing obliquely into the vena cava, as on the right side, enters the renal vein almost at right angles to its long axis, and, moreover, passes behind the rectum.

The veins composing the spermatic plexus can be ranged in three groups, the most anterior of which has in its midst the spermatic artery, the middle the vas deferens, and the posterior those veins which pass upward from the tail of

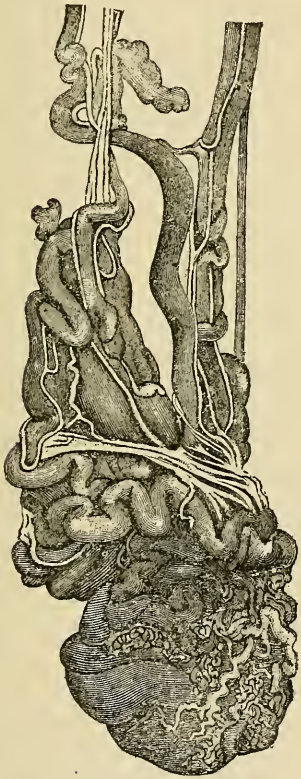


FIG. 191.—Varicocele. (Osborn.) Monod and Terrillon.

FIG. 192.—Varicocele of the left cord; the right testicle is undescended.

the epididymis. The anterior group is the one first affected, or, if the dilatation affects all the veins, is most extensively involved. Besides the mechanical conditions favoring the development of variocele, there are other causes, such as prolonged standing or walking, violent muscular exertion, masturbation, sexual excess, traumatism, inflammation, gonorrhœal epididymitis, and tumor-formations in the abdominal cavity, particularly swelling of the lumbar lymphatic glands or involvement of the kidneys. Hernia, heredity, constipation, have all been assigned as etiological factors, but their influence is not proved. Billroth states that varicocele is due to a diathesis which first affects the vessels of the pampiniform plexus, and later those of the rectum and the leg.

Symptoms.—The objective symptoms are as follows: The scrotum of the affected side is filled with a tortuous mass of veins, sometimes visible through the skin, and feeling like a bundle of worms. The tumor formed by these veins partly or completely disappears on lying down, but reappears on standing up, increasing in size gradually from below upward. Pressure exerted over the inguinal ring does not prevent the reappearance of the tumor. The scrotum is elongated (Fig. 192), may be dusky purplish in color; in advanced cases the testicle of the side involved is often markedly atrophied.

The subjective symptoms are—(1) pain in the testicle, the lumbar region, the hypogastrium, and often in the penis. It bears no relation to the size of the tumor. It may be agonizing or simply harassing. (2) Sexual neurasthenia, characterized by mental depression, sexual weakness or impotence, headache, nervousness, lack of power of concentrating the mind, and other vague general symptoms. Even quite large varicoceles may cause no subjective symptoms.

Varicocele may simulate omental hernia. The hernia has not, however, the characteristic feeling of a bundle of worms; if reduced it will not recur when pressure is made over the external inguinal ring, and it gives a much more distinct impulse on coughing than does varicocele. The development of the two affections is quite different.

Prognosis.—Varicocele observed in young men subject to prolonged and ungratified sexual excitement is usually cured by marriage, or, at least, it ceases to give trouble thereafter. If moderate in degree it has no marked tendency to increase, causes little pain, and does not appreciably alter the nutrition of the testicle. Quénu states that owing to the dilatation of the veins of the nerves there occurs a periphlebitis and neuritis, which would account for both pain and atrophy. Only when varicocele is so pronounced that circulation is materially interfered with does atrophy of the testicle result. Spontaneous cure seldom occurs, except in those rare acute cases which develop with mild inflammatory symptoms in consequence of strain or exposure. There is one form of varicocele frequently noted in old men, due to dilatation of the lower portion of the posterior group of veins and completely masking the lower portion of the epididymis. This is frequently followed by sclerosis of the lower testicular segment.

Treatment.—Treatment may be palliative or radical.

Palliative treatment consists in the proper regulation of the bowels, the avoidance of all exciting causes, such as violent muscular efforts or prolonged standing, the daily application of cold douches to the skin overlying the dilated veins, and the wearing of a properly fitted suspensory bandage. This treatment is indicated when the varicocele is moderate in size, when the nutrition of the testicle is not interfered with, and when the subjective symptoms are not pronounced.

Radical treatment is indicated when the varicocele is progressive or is well developed, when beginning atrophy of the testicle is observable, and when the subjective and reflex symptoms, particularly sexual neurasthenia, are pronounced.

The results of the operation are usually satisfactory. Exceptionally atrophy or even gangrene of the testicle follows ligation of the veins of the cord. Some-

times the reflex phenomena are unrelieved or even exaggerated, possibly because the neuritis originally caused by varicocele is progressive.

Resection of the Pampiniform Plexus.—Excision of the affected veins is best performed under ether, though local anæsthesia may be used. The operator by palpation finds the upper portion of the vas and presses it backward and inward away from the affected veins. An assistant standing to the left of the patient makes firm pressure by means of the thumb and fingers of the right hand at the point which will keep the vas back and the enlarged veins forward. The surgeon, passing his fingers lower down, again separates the vas from the veins, and the assistant, placing the palmar surface of the left hand beneath the scrotum, presses firmly with the thumb and fingers, keeping the lower part

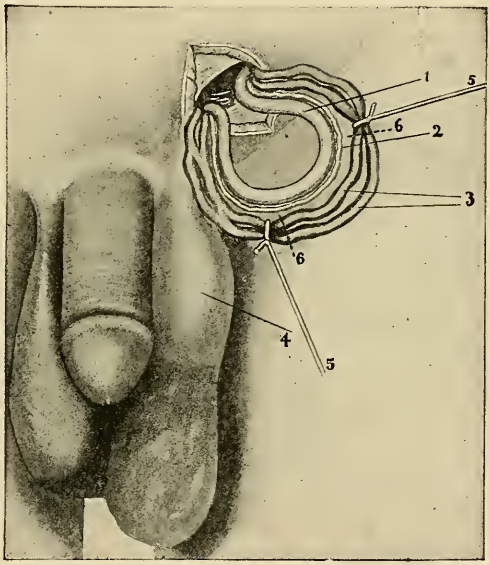


FIG. 193.—Resection of spermatic veins through an inguinal incision. 1, vas; 2, deferential vessels; 3, spermatic veins; 4, testicle; 5, ligatures; 6, points at which veins are to be divided. (From Keen's Surgery, W. B. Saunders Co.)

of the vas away from the group of dilated veins. By slight tension with the left hand the skin of the scrotum is made taut. The surgeon makes a longitudinal incision two inches in length over the most prominent part of the varicocele, dividing the skin, dartos, and fibrous investment of the cord. The veins are freed by blunt dissection for two or three inches of their course, and an aneurism needle, threaded with catgut, is passed beneath the entire group at the lower end of the incision; the needle is unthreaded and withdrawn; another needle, similarly threaded, is passed beneath the veins at the upper end; thus they are included in two catgut loops separated from each other by an interval of at least two inches. These ligatures are tied tightly with a triple knot. A few catgut sutures passed through the coverings of the cord above and below the points where the veins have been divided serve to shorten the cord and elevate the testicle. The skin wound is closed without drainage.

This operation may also be performed through a transverse incision just below the external ring (Fig. 193), as advocated by Bevan.

When the posterior group of veins is markedly involved, forming a doughy tumor behind and below the epididymis, these vessels should also be ligated and excised.

Shortening of the Scrotum and Resection of the Veins.—In a large proportion of cases there is a marked elongation of the scrotum associated with the venous enlargement. These cases are only partially relieved by the operation on the varicocele, so in such cases shortening of the scrotum should constitute a part of the operative procedure.

This is performed by drawing the scrotum strongly downward, while an assistant keeps the testicles up by holding the scrotum between neighboring fingers; or a Doyen intestinal clamp may be used in place of the fingers. So

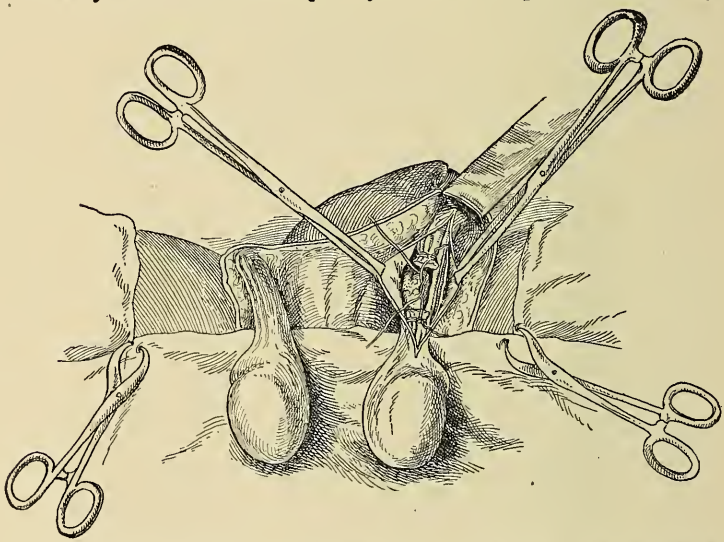


Fig. 194.—Varicocele operation. The lower portion of the scrotum has been resected.

much should be removed (Fig. 194) that at the conclusion of the operation the skin shall be stretched snugly over the testicles. As soon as the incision has been made, scissors being used for the purpose, bleeding points are carefully clamped and tied. The varicocele is then dealt with in the manner described above. The dartos and skin are then closed with continuous sutures of catgut and silk, starting the sutures at the raphe.

The dressing consists of gauze held in place by a crossed bandage of the perineum, or an athletic supporter.

VASECTOMY

This operation is employed as a means of sterilizing defectives in certain states. The vas is usually most accessible through the posterior surface of the scrotum. It is isolated from its surrounding veins, and is held in place close beneath the skin, which is stretched tightly over it by the two hands of an assistant, the thumbs and forefingers making firm pressure and holding the vas

away from the other structures of the cord. The skin overlying the vas is then infiltrated with novocaine solution and is divided; the fibrous tissue overlying the vas is cut through, the vas itself is isolated and hooked out with a grooved director, is freed for an inch, and a ligature applied above and below, and the portion lying between the ligatures is removed. The wound is closed by a stitch, and the testicle is enveloped in sterile gauze and supported by a crossed of the perineum bandage.

VASOPUNCTURE AND VASOSTOMY

These procedures are employed for the purpose of medicating and draining the seminal vesicles, the former operation providing for but a single medication, the latter for repeated applications.

The vas is isolated as in the preceding operation. Then, if a simple puncture is to be made, the wall of the vas is perforated by the needle of a hypodermic syringe filled with the lotion of choice, usually one of the silver preparations. If vasostomy is to be performed, an incision ⅜ to ½ inch long is made in the vas, and the lips of this wound are sewn to the skin at the upper angle of the scrotal wound, three or four sutures running from the mucosa of the vas outward through the skin. If the suture at the upper angle of the scrotal wound be of silkworm gut, it serves as a guide for the injection of lotions.

CHAPTER XVII

SURGERY OF THE SEMINAL VESICLES

ANATOMY

The seminal vesicles, two pouches lined with secreting columnar epithelium, lie between the bladder and the rectum, extending upward and outward for approximately two inches from the base of the prostate (Fig. 195), to the outer sides of the vasa deferentia. They are held close to the bladder by two enveloping layers of fascia, the posterior layer of which is in intimate relation with the anterior layer of the fascia of Denonvilliers, which passes down to cover the posterior surface of the prostate (see Chapter XVIII). Each vesicle is approximately three-quarters of an inch wide, and one-quarter of an inch thick, the usual length being two inches. There is a marked difference, however, in the forms and sizes of individual specimens. Picker describes five main types, namely:

Simple straight tubes	4 per cent.
Thick, twisted tubes, with or without diverticula	15 per cent.
Thin, twisted tubes, with or without diverticula	15 per cent.
Main tube straight or twisted, with larger grape-like arranged diverticula (Fig. 196)	33 per cent.
Short main tube with large irregular ramifying branches	33 per cent.

He notes that the holding capacity of different specimens varies from 2 cc. to 11.5 cc., while the length of the unraveled tube varies from 4 to 23 cm.

The vesicles contain muscular fibres in their walls for the ejection of their contents during intercourse.

Below the vesicles terminate in small ducts which unite with the vasa to form the ejaculatory ducts (Fig. 197). These latter enter the substance of the prostate at its base, and passing through a fascia-lined tunnel open in the prostatic urethra, usually on the lips of the sinus pocularis.

The vesicles receive their blood-supply through the inferior vesical and middle hemorrhoidal arteries. Their nerves are derived from the hypogastric plexus.

Anomalies of the Seminal Vesicles.—The seminal vesicles may be absent; in this case there is usually absence of the testicles. Unilateral absence has been noted in conjunction with unilateral malformations, involving structures other than the testicle or the cord. Hunter has reported fusion of the vesicles, the ducts of the two glands uniting and ending in a blind pouch. Multiple vesicles have been observed. Atrophy of the vesicles has been frequently noted at post-mortem examination and quite independent of any affection of the urethra or the testicles. Communication with the ureter also has been observed, this condition, which obtains during fœtal life, having persisted.

The ejaculatory ducts may be partially wanting, may be entirely absent, or

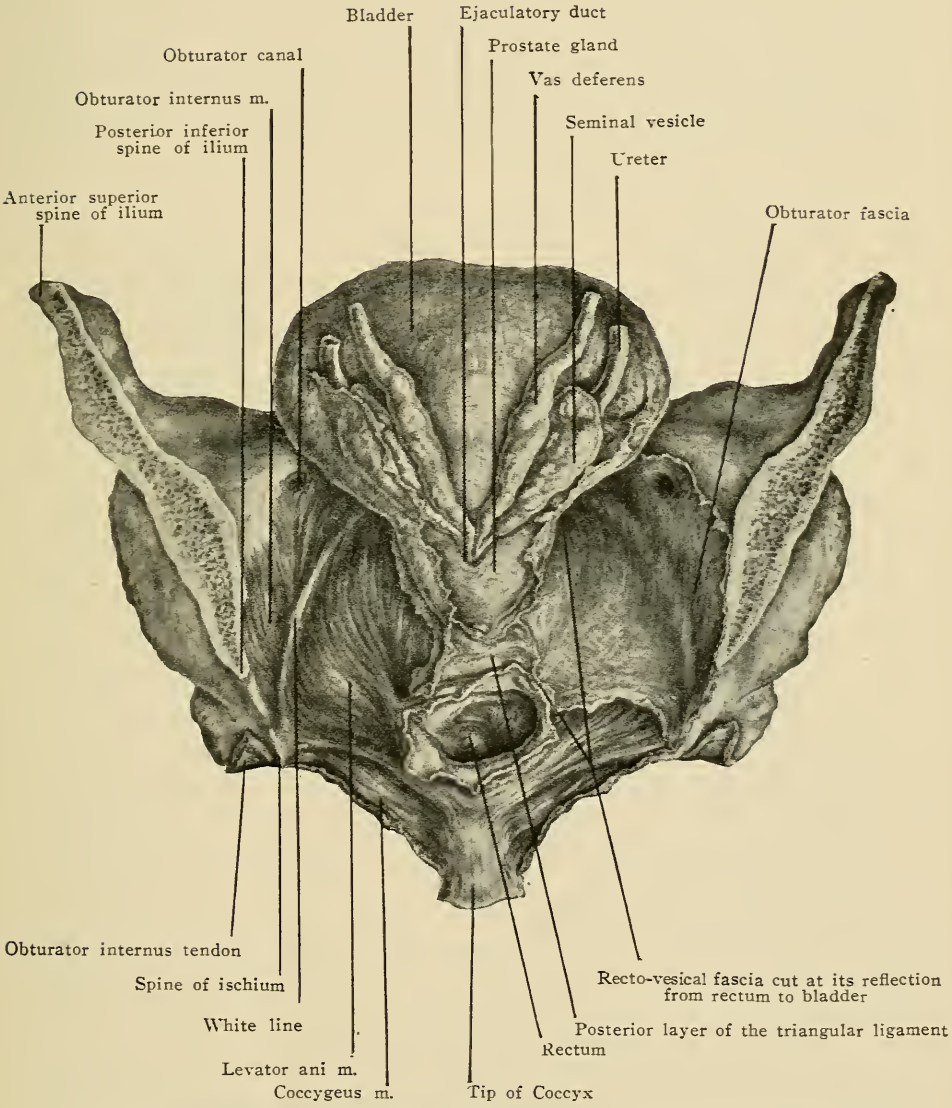


FIG. 195.—Bladder, prostate, seminal vesicles, and vasa deferentia. (Deaver's Surgical Anatomy, P. Blakiston's Son & Co.)

may be fused; they may pass directly into the prostatic utricle, or may continue forward into a canal opening at some point on the glans penis, this condition giving rise to the misconception of a double urethra.

PHYSIOLOGY

The functions of the seminal vesicles seem to be to store the semen, to dilute it with the vesicular secretion, and finally to expel it into the prostatic urethra during sexual intercourse. To insure the flow of the spermatic fluid

FIG. 196.

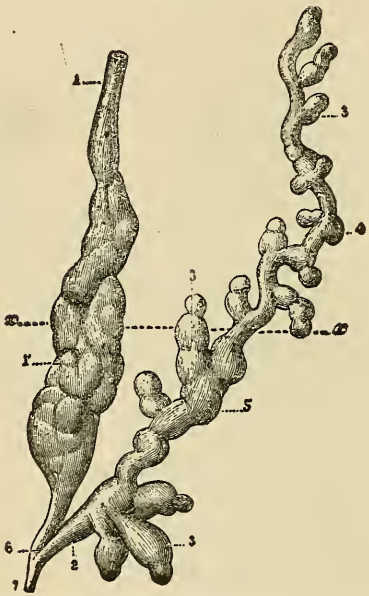


FIG. 196.—Right seminal vesicle, posterior surface, dissected out. 1, deferent canal, with (1′) the ampulla; 2, seminal vesicle, with (3) lateral prolongations, (4) cæcal dilatations, and (5) parietal projections; 6, union of the vesicle with the vas; 7, ejaculatory duct; *xx* marks the position of the posterior extremity of the undissected vesicle. (Testut.)

FIG. 197.

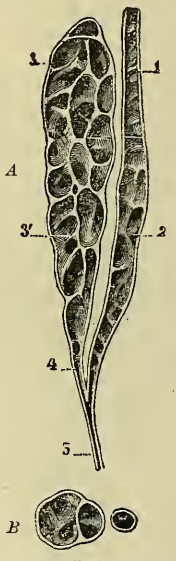


FIG. 197.—Deferent canal and seminal vesicle. *A*, longitudinal, *B*, transverse section; 1, deferent canal; 2, its ampullated portion; 3, seminal vesicle with (3′) pouches; 4, terminal portion; 5, ejaculatory duct. (Testut.)

into the vesicle rather than into the urethra except during the sexual act, the ejaculatory duct is furnished with a sphincter, which closes the duct except during coitus.

Injuries of the Seminal Vesicles

From their position the seminal vesicles are well protected against traumatism, except that which is so extensive that other lesions overshadow in importance the injuries to the vesicles.

When both vasa or both ejaculatory ducts are divided or torn it is extremely probable that sterility will result from obliteration. A wound of the seminal vesicle alone is of minor importance, though it is conceivable that it might be followed by fistula. The treatment of wounds of the seminal vesicles is conducted in accordance with general principles.

ACUTE VESICULITIS OR SPERMATOCYSTITIS

The usual cause of this affection is extension of gonorrhœal inflammation into the congested seminal vesicles. It may be due also to infection with the ordinary pus microbes and with the colon bacillus.

Symptoms.—The onset of acute seminal vesiculitis is characterized by practically the same symptoms as those noted in describing acute posterior urethritis. There are frequent, straining, painful micturition, and constant or shooting pains in the perineum, hypogastric region, and about the anus; the pain is often referred to the hip-joint and sacroiliac articulation of the affected side, and may run down the outer side of the leg. Both direct and reflected pains are made worse by micturition and defecation. At times there are retention of urine and violent rectal tenesmus, the suffering being so intense that an opiate is required. Exceptionally the disease is ushered in with the fulminant symptoms of an acute peritonitis. There are vomiting, tympany, constipation, and tenderness over the whole lower belly-segment. Persistent erections are frequent; painful emissions of blood-stained semen are not uncommon.

Rectal examination shows at once a hot, tender, obscurely fluctuating mass passing upward and outward from the prostate, usually about the size of the thumb, with its upper limit beyond the reach of the examining finger. Usually the inflammatory swelling causes a bulging of the entire space lying above the prostate suggesting to the examining finger an enlargement of the gland.

Sometimes acute vesiculitis develops insidiously. The patient is not confined to bed, but may complain of shooting intermittent pains of moderate severity in the perineum, with rheumatic aches felt in the hip, sacro-iliac joint, rectum, and perineum, or down the outer and inner surfaces of the leg.

Diagnosis.—The diagnosis of acute seminal vesiculitis is founded on rectal examination. This should be conducted with a fairly full bladder, the patient leaning forward over a chair, with the legs slightly separated; or he may be put in the lithotomy position and the base of the bladder outlined by bimanual palpation, the fingers of one hand being placed deeply behind the pubis, while the index of the other hand is introduced into the rectum. Palpation is the only means of making a differential diagnosis from prostatitis or posterior urethritis, and it must be noted that it does not enable the surgeon to distinguish definitely between spermato-cystitis and inflammation of the ampulla of the vas. In both cases the swelling, at least during the acute stage, is mainly due to infiltration of the intertubular and periglandular connective tissue. When both sides are involved this infiltration may be so extensive as to form a large projecting mass more prominent than the prostate and extending from the outer border of one vesicle to that of the other, completely masking the base of the bladder. This condition is often mistaken for acute prostatitis, but careful palpation will outline the prostate and show that it is normal in size. Usually the infiltration is not so extensive, the inflammation when bilateral forming two distinct masses. The pain referred to the hip-joint seems particularly characteristic of involvement of the vesicles.

Seminal vesiculitis has been mistaken for appendicitis, and the symptoms may be identical. A history of urethral discharge would suggest a rectal examination which would clarify the diagnosis.

Prognosis.—So far as early cure is concerned, the prognosis must be guarded, as suppuration once established in the convoluted tubule which makes up the bulk of this gland is difficult to cure. So far as recovery from immediate symptoms is concerned, the prognosis is extremely favorable, the disease usually undergoing partial spontaneous resolution whether treatment is adopted or not. There is, however, a remote possibility of periglandular suppuration, with the formation of an abscess, which may rupture into the rectum, the bladder, or the peritoneal cavity. The inflammation frequently travels backward along the vas, causing epididymitis.

The usual termination of the affection is a chronic vesiculitis, which causes either no symptoms or those of urinary or genital irritability, and which has an ultimate tendency to recovery, though this may take months or years.

CHRONIC VESICULITIS

This is the usual termination of acute inflammation. Often it is the terminal stage of a subacute form of the disease, whose onset is so insidious as to be imperceptible; the symptoms of subacute vesiculitis are similar to those of the chronic condition. All the causes of pelvic engorgement predispose to its development; its indefinite prolongation is probably due to inadequate drainage, increased at times by a strictured condition of the ejaculatory duct, which may become completely obliterated.

Symptoms.—The symptoms of chronic vesiculitis are practically those of chronic posterior urethritis—*i.e.*, the patient is subject to irregular and apparently causeless attacks of frequent, urgent urination; he suffers from a gleet, which is also subject to exacerbations and remissions, or may light up after each intercourse; mild attacks of epididymitis develop occasionally; there is often alteration in the sexual power and appetite, and frequently there are developed pronounced symptoms of sexual neurasthenia, with pains referred to the back, hypogastrium, and thighs. Aching pain in the testicles is a not unusual symptom.

Chronic osteo-arthritis of gonococcal origin seems oftenest to be associated with this form of vesiculitis. The organisms found in the vesicles at this time, however, are not gonococci; usually they belong to the colon group, or are the ordinary organisms of suppuration.

Diagnosis.—The diagnosis of chronic vesiculitis is made in part from an examination of the vesicles with the finger in the rectum, and in part from an examination of the expressed secretion.

To the palpating finger chronically inflamed vesicles appear slightly denser than the surrounding tissues, and may be distinctly indurated. For the microscopic examination of the secretion, four to six ounces of sterile water or normal saline solution should be placed in the thoroughly cleansed bladder, the urethra also having been irrigated, and the vesicles emptied of their secretion by stripping them from above downward with the finger, counter-pressure being made above the pubis to bring the organs better within reach of the finger. Care must be taken not to make pressure upon the prostate. If the secretion appears at the meatus this should be caught on a slide and examined; should no secretion so appear the content of the bladder should be centrifuged and

preparations made from the sediment. As the normal secretion contains only occasional leucocytes, any excess of these elements is an indication of an inflammatory condition. An intimate admixture of spermatozoa is a strong indication that the fluid has come from the vesicles or the ampullæ of the vasa, rather than from the prostate.

Treatment of Vesiculitis.—The prophylaxis of seminal vesiculitis consists in adopting every possible means of lessening the severity of posterior urethritis. It is evident that a comparatively slight amount of inflammatory swelling will entirely block the ejaculatory duct; hence irritating injections or applications, the passage of instruments, or any manipulation which tends to aggravate the posterior urethritis during the acute stage of the disease should be avoided.

For the acute condition, rest in bed, elevation of the pelvis, rectal injections of hot or cold saline solution, and hot sitz-baths or general baths are especially useful in lessening pain and congestion. Usually opium and belladonna suppositories are required. The methods described for chronic vesiculitis are at times also applicable to the acute infection.

In the treatment of the chronic condition provision must be made for improved drainage of the organs, and at times for medication of their interior.

Drainage may be facilitated by massage or stripping of the vesicles, by vasostomy, or by vesiculotomy. Direct medication may be applied through a vasostomy opening, or, if but a single application is desired, by exposing the vas and puncturing it with a small needle. Vesiculectomy is demanded but rarely in particularly intractable cases.

The evacuation of the contents of the vesicles by stripping them in the manner described in the section on "Diagnosis" is the most generally useful method of treatment. It should be employed not oftener than twice a week and should not be applied with sufficient force to cause immediate pain or secondary inflammatory reaction. It may have to be continued for many months, and must always be supplemented by the treatment appropriate to stricture or anterior or posterior urethritis when these conditions are also present. Posterior urethritis is practically always present when the seminal vesicles are inflamed.

Vasostomy was introduced by Belfield, and is performed in the manner described on page 371. Thirty minims of any lotion desired, usually one of the silver preparations in a strength suitable for use in the urethra, are injected with a syringe armed with a blunt needle once or twice a week, the medicine flowing into the vesicle rather than into the urethra on account of the obstruction offered by the sphincter of the ejaculatory duct.

Vesiculotomy and vesiculectomy are best performed through a semilunar or inverted V incision between the scrotum and the anus, the patient being in the high lithotomy position, as for perineal prostatectomy. The incision is made through the skin and superficial fascia, after which the spaces to the sides of the central tendon are deepened by blunt dissection, the levator and muscles being pushed back and the transversus perinei forward. The finger is then passed above the central tendon and recto-urethralis muscle, and these are divided close to the urethra to avoid injuring the rectum. It is then possible to separate the rectum from the prostate and vesicles by means of the fingers and

gauze sponging. If then the rectum be held back with a broad rectractor, and the prostate be drawn down by means of heavy silk sutures inserted into the prostatic capsule, one at each side of the base of the organ, as recommended by Squier, it is possible to get an excellent view of swollen vesicles as they lie beneath the fascia of Dénonvilliers, which must be incised for their attack. Vesiculotomy, the operation usually indicated, is performed by incising the vesicles directly through this fascia, the incisions being made wherever there appear to be collections of pus. A drainage-tube is then sewed into the largest incision in each vesicle, and strips of gauze are laid in beside the tubes. The tubes are allowed to remain for a week or ten days, and the gauze a few days longer. In closing the wound the levator ani muscles are drawn together behind the drainage material as after prostatectomy.

In the performance of vesiculectomy the separation of the layers of Dénonvillier's fascia is continued upward till the extremities of the vesicles are exposed, retractors being inserted so that a good view may be obtained. The fascia overlying the vesicles is not incised for the full length of each of these organs. In searching for the vesicles it must be remembered that their tips are often widely separated, directed toward the sides of the pelvis; should the fascia be stripped up in their quest, the vesicles will often be found adherent to its anterior surface. Theoretically the removal of the pouches is best effected from above downward; practically it may be easier to free the most accessible portion first, and by traction upon it and blunt dissection bring within reach the upper pole. Care must be exercised not to injure the vas as the lower portion is dissected out; the ureter is less likely to be injured, as it enters the bladder wall at about the level of the upper extremity of the vesicle. The operation has been followed by impotence.

TUBERCULOSIS OF THE SEMINAL VESICLES

Tuberculous vesiculitis is nearly always secondary to involvement of the prostate and the prostatic urethra or the epididymis, though clinically, cases are sometimes observed in which distinct nodulation of the vesicle can be felt, the prostate being apparently healthy, and symptoms pointing to involvement of the prostatic urethra being absent. The invasion of these structures is often simultaneous. Clinically, we have many times noted tuberculous vesiculitis precede by weeks or months palpable lesions of the epididymis. As a rule, when a tuberculous epididymitis becomes demonstrable, the vesicle of the affected side is palpably involved.

Tuberculous vesiculitis is characterized by the formation of a smooth or nodular, hard or semi-fluctuating tumor, easily detected on rectal palpation. Both seminal vesicles are often involved, with infiltration of the fibrous tissue lying between them, forming a mass practically continuous with the prostate and entirely obscuring the base of the bladder. The infiltrated mass is rarely sensitive, and in the absence of involvement of the prostatic urethra may cause few symptoms, but sexual erethism, bloody semen, pain during or after ejaculation, and finally sterility and impotence are fairly common. The infiltrate often breaks down, forming typical irregular sinuses, discharging into the rectum

and perineum. Tuberculous vesiculitis essentially an affection of the adult.

Diagnosis.—The diagnosis of tuberculous vesiculitis is founded upon the discovery of an irregular, nodulated, non-sensitive growth occupying the position of the seminal vesicle, and associated with other symptoms or signs of genito-urinary tuberculosis, such as nodulation of the epididymis, frequent urination, with passage of blood and the finding of tubercle bacilli in the urine or the semen. The ejaculation of bloody semen in the absence of other cause, such as gonorrhœal spermato-cystitis, is suggestive rather than characteristic.

Tuberculous vesiculitis occurring in the course of gonorrhœal posterior urethritis can be recognized only by the gradual development of a nodular semi-fluctuating tumor. The tuberculin test may aid in determining the diagnosis.

The termination is usually in suppuration and the formation of fistulous tracts. Spontaneous cure has been reported following evacuation of abscesses.

Treatment.—In the absence of symptoms, and when nodulation of the epididymis is non-progressive, treatment may be confined to the general hygienic, dietetic, and medicinal measures applicable to tuberculosis. As in all inflammations or infiltrations of the pelvic viscera, regular evacuations from the bowels are of extreme importance, and as a means of lessening local congestion the urine should be rendered unirritating and should be passed at regular intervals. If in spite of careful treatment inflammation is steadily extending, excision of the infiltrated vesicle is indicated, even though experience has shown that a few of these cases after discharging undergo resolution.

The objection to excision is that the prostate is commonly involved in the tuberculous process, that the bladder-walls are frequently infiltrated, and that complete removal may be followed by fistula formation.

Great size, larger than the last joint of the thumb, fistula formation, persistent toxic symptoms, and interference with defecation are the indications usually given for vesiculectomy. Spontaneous healing may occur following the removal of a tuberculous focus in the testicle, or as a result of tuberculin treatment.

Malignant Growths

These are secondary to involvement of the adjoining organs, and are obscured by them.

Cystic Swelling of the Seminal Vesicles

Usually as the result of obstruction of the ejaculatory ducts, conversion of the whole vesicle into a large single cyst or distention of one or more of its diverticula may occur; in the latter case the enlargement is made up of a number of small cysts. This affection may run its course without exhibiting symptoms other than those incident to chronic inflammation until the tumor reaches sufficient size to produce pressure effects. Cases are reported in which the cyst reached enormous dimensions. In one case quoted by Jacobson ten pints of brown serous fluid were drawn off. After two tappings the cyst did not refill.

The diagnosis is based on rectal palpation. This condition can scarcely be differentiated from dermoid cysts, or cysts due to the rapid development of the remains of fœtal structures.

Treatment.—The treatment in such cases is aspiration, which may be twice

repeated. In case this fails, permanent drainage may be established through a perineal opening, or the cyst may be excised.

Spermatocystic Concretions

These concretions are probably formed originally because of obstruction of the duct. They are made up of spermatozoa, mucus, and epithelium, and are whitish in color, becoming darker with age and undergoing calcification. Their importance lies in the fact that they may occlude the ejaculatory duct, thus producing sterility and rendering the cure of vesiculitis impossible. The symptoms are pain on emission, associated, perhaps, with the symptoms of posterior urethritis, such as frequent urination and tenesmus.

The diagnosis is made by rectal examination, which may demonstrate one or more hard bodies in the seminal vesicles.

Treatment consists in breaking up these concretions by pressure through the rectum exerted against a full-sized sound passed into the bladder.

CHAPTER XVIII

SURGERY OF THE PROSTATE

ANATOMY

In the twelfth week of fœtal life five groups of tubules grow out from the posterior urethra, from the floor between the ejaculatory ducts and the bladder (middle lobe), from the prostatic furrows (lateral lobes), from the floor beyond the ejaculatory ducts (posterior lobe), and from the anterior wall (anterior lobe), to become the five lobes of the prostate gland (see Fig. 198). Small groups of glands known as subcervical glands of Albarran and the subtrigonal glands, not penetrating deeper than the submucosa and not related to the prostate except by position, make their appearance at the sixteenth and twentieth weeks respectively (Lowsley).

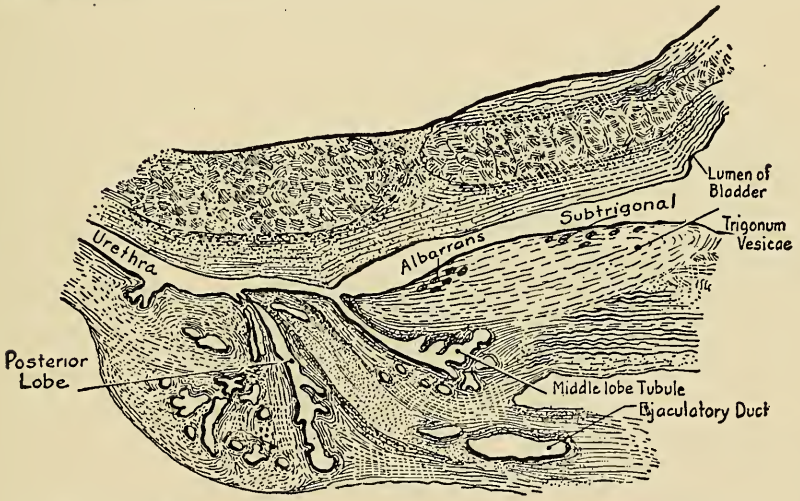


Fig. 198.—Sagittal section of prostate of 16-cm. human fœtus of 5 months; + 15. From an article by Lowsley, (Journal of the American Medical Association, lx, 113, Jan. 11, 1913).

The prostate in its developed form is a genital organ, made up of glandular tissue with a considerable admixture of smooth muscular fibres and connective tissue; the proportion varies in different parts of the organ, the glandular tissue being most marked in the lateral lobes, and the muscular and fibrous tissue in the preurethral portion. It varies greatly in size. In children it is rudimental; at the age of puberty it grows rapidly, but does not attain its full development until about the twenty-fifth year; at about the fiftieth year there is a further slight increase of size, due to hyperplasia of the glandular and fibrous elements, the muscular tissue showing rather a tendency to atrophy. On an average the normal adult prostate has a length of 3.29 cm., a width of 4.1 cm., and a thickness of 1.9 cm. (Lowsley, Wilson and McGrath, Cuthbert Wallace, and Sir Henry

Thompson). It weighs about four to five drachms. Its fibromuscular capsule is intimately connected with the gland substance; its outer surface can be stripped from the prostatic sheath with comparative ease. The stroma is composed of smooth muscle fibres and connective-tissue elements. Bands of muscle and con-

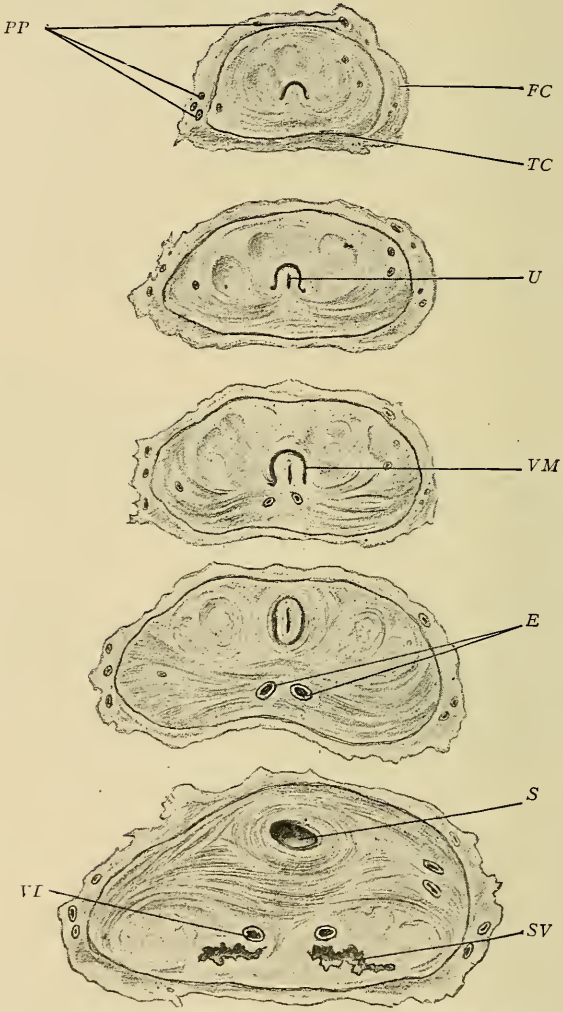


FIG. 199.—Serial cross-sections of prostate from apex to base. S, Internal vesical sphincter; SV, seminal vesicle; VD, vas deferens; E, ejaculatory ducts; VM, verumontanum; U, utricle; PPV, periprostatic plexus of veins; TC, true capsule of prostate; FC, false capsule.

nective tissue pass from the capsule into the substance of the gland, separating the lobules and giving each a distinct investment. The gland is made up of from forty to sixty of these lobules.

In shape the prostate has been likened to a chestnut, a seal-ring, a pyramid,

but none of these similes are entirely satisfactory. The organ surrounds the first part of the urethra (Fig. 199), and is applied closely to the base of the bladder, this vesical surface, looking forward and upward, being the base of the organ, while the apex is found at the point of junction of the membranous and prostatic urethras. The posterior surface faces the rectum, and in many specimens is marked by a median groove. The border between the base and posterior surface is separated from the bladder by the lower extremities of the seminal vesicles, and usually exhibits a distinct notch at its midpoint.

There is an anterior portion of the prostate, a commissure lying in front of the urethra, consisting mainly of muscular and fibrous tissue, and of little interest from a surgical standpoint; a median portion, lying between the urethra and the ejaculatory ducts; two lateral lobes lying to the sides of the median portion, consisting largely of glandular tissue, and being the sites of prostatic hypertrophy; and a posterior portion, lying behind the ejaculatory ducts, and described as the usual seat of cancerous change.

The prostate is placed behind and slightly below the symphysis pubis, lying between the posterior layer of the triangular ligament and the neck of the bladder, which is surrounded by its base. It is covered by its capsule, composed of fibrous and muscular tissue, while outside of this are reflections of the rectovesical fascia, the so-called "sheath" of the prostate, which binds it firmly in its position in the pelvis. Three layers of this fascia are described. One passes in front of the organ, between it and the pubis, and contains the venous plexus of Santorini (Fig. 200). The other two layers pass over the lateral and posterior aspects of the gland, being the two layers of the fascia of Dénonvilliers. The anterior of these is adherent to the prostate, and contains in its lateral portions the periprostatic plexus; it presents a substantial barrier to the backward extension of prostatic carcinoma. The posterior layer is easily separated from the anterior, and is closely associated with the rectum.

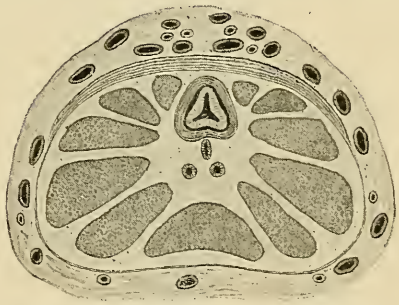


FIG. 200.—Plexus of vessels surrounding the prostate within the meshes of the false capsule. (Testut.)

The muscular and glandular connections between the normal prostatic lobes and the urethra are so intimate that it is impossible to remove the former by avulsion or blunt dissection without extensive laceration or destruction of the latter. The greater number of excretory ducts open upon the floor of the prostatic urethra passing somewhat obliquely. Some open into the sides or the roof of the canal.

The blood-supply of the prostate is derived from the internal pudic, vesical, and hemorrhoidal arteries. The veins are particularly numerous, and form a rich plexus about the sides, base, and anterior surface of the gland. The nerves are from the pudic and the hypogastric plexus.

According to Lowsley, the lymphatic radicals, arising about the glandular acini, form a secondary plexus beneath the prostatic capsule. Several trunks

leave the posterior surface of the organ, passing to the external and internal iliac nodes, and to the lateral sacral nodes and those of the sacral promontory; anterior trunks are joined by vessels coming from the membranous and prostatic portions of the urethra, and run to the nodes on the internal pudic arteries.

The nerves of the prostate are chiefly sympathetic fibres originating from the inferior hypogastric plexus. Timofeew has shown that the prostate contains a most elaborate system of nerve-fibres and nerve-endings. There is direct communication between the nerve-supply of the prostate and that of the seminal vesicles. A few fibres from the anterior roots of the third and fourth sacral nerves are present.

PHYSIOLOGY

The prostate contributes to the semen a thin, opalescent, albuminous fluid, containing lecithin bodies, a few epithelial cells of the columnar type, amyloid bodies, and an occasional leucocyte. The purpose of this fluid seems to be to give the semen greater volume, and to render the spermatozoa more actively motile and viable for a greater length of time within the female genitalia.

In addition to its secretory function, the prostate is also charged with the duty of expelling its secretions during intercourse, and probably also with the expulsion of the last drops of urine from the posterior urethra, in connection with the perineal muscles.

The nerve supply of the prostate is a rich one, so that the condition of this organ exerts a powerful influence on other structures and their functions, particularly those of the genital system. It is not unusual for infection of the prostate to exert a more powerful influence on the mental and general nervous condition of the individual than an infection of like grade in some other organ.

INJURIES OF THE PROSTATE

Contusion of the prostate is probably a commoner accident than is generally supposed. It may be caused by kicks or blows in the posterior perineum, or by jars such as may be received in horseback or bicycle riding. The symptoms are those of acute prostatic congestion—*i.e.*, deep-seated pain, tenesmus, moderate ardor urinæ, frequency and urgency of urination, and sometimes a sense of rectal fulness. These symptoms subside in a few hours or a few days, and, unless there has been a preceding latent lesion, are unattended by sequelæ.

The pathological alterations which take place from comparatively slight contusions are unknown, since they never result fatally. It is possible that in the severer forms there are slight multiple parenchymatous hemorrhages.

Wounds of the prostate, except those inflicted during the course of a surgical operation, are of minor importance, since this gland is so placed that the vulnerating body which reaches it almost necessarily involves other and more important structures. Incision into the prostate practised during the course of surgical operations is unattended by danger, unless the rich plexus of veins about this gland is also involved. The hemorrhage then may be serious or even fatal. From the prostate itself bleeding is usually moderate, or, if severe, is readily controlled by packing.

Should infection occur, wounds of the prostate may be extremely dangerous, since septic phlebitis may result, rapidly extending along the large, freely anastomosing pelvic veins, and causing septicæmia or pyæmia.

Prostatic wounds involving the urethra are subject to the dangers of internal hemorrhage and urinary infiltration. The blood may flow backward into the bladder, filling it with a thick, clotted mass, which may be extremely difficult to dislodge. If the bleeding is profuse, a hard, globular tumor may form above the pubis.

Prognosis.—Wounds of the prostate, particularly those which do not involve the urethra, heal promptly, provided they are kept clean. When the urethra is opened there is little danger of urinary extravasation if abundant provision is made for drainage. These wounds generally heal kindly, and are seldom followed by urinary fistula or interference with micturition; exceptionally the formation of a prostatic cicatrix interferes with the action of the vesical sphincter and causes a more or less permanent condition of incontinence.

When the prostate is extensively injured and the capsular investment widely torn, dangerous complications, such as pelvic cellulitis and even peritonitis, may follow. The lacerated and contused wounds caused by unskilful catheterization, as a rule, heal kindly, provided the urine is not infected. If this fluid is septic or if the prostate is already infected, abscess-formation, phlebitis, and infiltration, even ending in septicæmia and death, are possible.

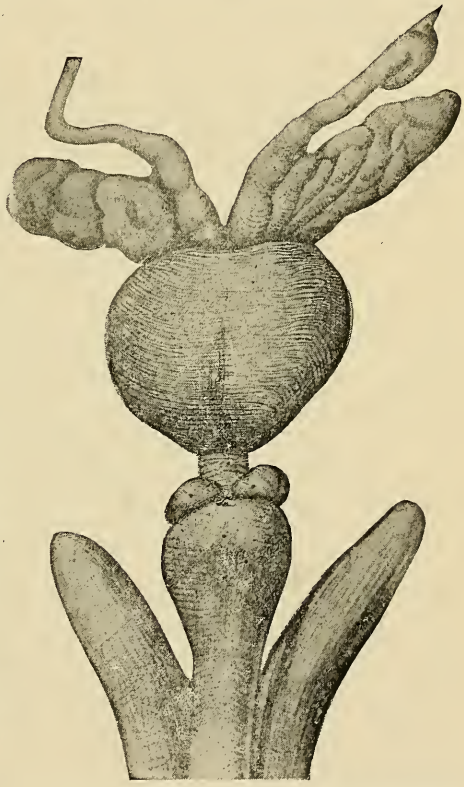


FIG. 201.—Ejaculatory ducts, seminal vesicles, prostate, membranous urethra, Cowper's glands, bulbous urethra, corpora cavernosa. (Murphy.)

Treatment.—A wound of the prostate not involving the urethra should be cleansed and packed with sterile gauze. If in the course of twenty-four hours urination becomes difficult, consequent upon inflammatory action, a permanent catheter should be worn for two or three days, in the manner described when treating of retention of urine from enlarged prostate. If the prostatic urethra or the vesical neck has been opened, a soft catheter should be passed through the urethra into the bladder, and retained there for several days, and the perineal wound should be cleansed and packed. If it is impossible to introduce an instrument into the bladder, median perineal urethrotomy should be performed, and a large, soft drainage-tube should be carried through this opening into the bladder and retained there. If there is bleeding, the catheter *en chemise* should be introduced.

When the wound has been caused by forced catheterization and the bladder is full of blood, this should be withdrawn by suction through a large woven or metal catheter, or through the evacuating-tube used in litholapaxy, if this instrument can be introduced. A full-sized catheter is then passed into the bladder and is retained for several days, the bladder and urethra being flushed out several times daily with a mild antiseptic solution.

Should symptoms of local abscess or septic infection develop, the prostate should be opened by median perineal urethrotomy and thorough drainage secured through this opening. If after wounding the prostate by forced catherization no instrument can be introduced into the bladder, median cystotomy should be performed. When hemorrhage into the bladder is unattended with symptoms of distention or local inflammation, surgical intervention may be delayed, provided the urine is sterile and the urethral instrumentation has been practised with proper antiseptic precautions. There is, however, always a risk of bacterial infection: hence it is wiser to remove the clots by vesical irrigation with antiseptic solutions. The Thiersch solution will usually suffice. Urinary antiseptics should at the same time be given by the mouth.

PROSTATITIS

Inflammation of the prostate may be acute or chronic; it has also been classed as follicular,—*i.e.*, confined to the glands and periglandular tissue,—or parenchymatous, attacking the entire organ.

Acute Prostatitis

Causes.—Congestion is a condition which strongly predisposes to infection, and which is apparently essential to its development. Congestion may be due to traumatism, as from instrumentation or jarring of the perineum, excessive venery, constipation, masturbation, prolonged ungratified sexual excitement, hemorrhoids, irritating applications, strongly acid or alkaline conditions of the urine, urethral calculi, varicose condition of the prostatic plexus, over-distention of the bladder, atheromatous vessels, chilling, over-fatigue, and a variety of other causes.

The immediate cause of prostatitis is infection. It is true that inflammatory reaction invariably follows traumatism, but in the absence of infection this undergoes prompt resolution. Infection may be conveyed along the urethra, as in the case of gonorrhœa; may be either hæmatogenous or carried by the urine, as in prostatitis which complicates small-pox, scarlet fever, typhus, typhoid, and other infectious diseases; or may reach the prostate by contiguity of structure, as from periprostatic suppuration.

The common causes of acute prostatitis are the backward extension of gonorrhœal urethritis and the introduction of unclean instruments.

Pathology.—Acute prostatitis is characterized by increased vascularity throughout the gland, with marked dilatation of the prostatic plexus of veins (Fig. 202). The inflammation, usually beginning in the mucous membrane of the urethra, extends primarily along the ducts of the glands, and secondarily, when these have become obstructed, forms suppurating retention cysts, through

the parenchyma of the organ. Abscesses may appear in the form of small multiple foci or as large collections. The small foci represent the glands transformed to sacs containing mucus, epithelium, and pus, the ducts being partially or completely obstructed. As the inflammatory secretion increases in quantity the glandular capsule may rupture, several of the suppurating glands becoming confluent, forming large accumulations. The ejaculatory ducts are always involved in the general catarrhal inflammation, and frequently become occluded from inflammatory swelling and epithelial proliferation. There results tension in the seminal vesicles and the ampullæ of the vasa. This increases congestion, and thus strongly predisposes to further extension of inflammation. The prostatic utricle is also involved.

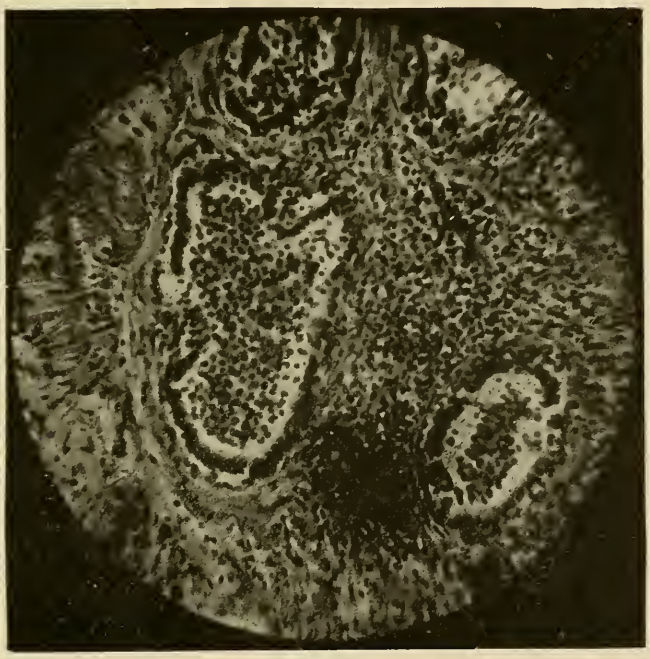


FIG. 202.—Acute catarrhal prostatitis. Note the endo- and periglandular round-celled infiltration; also about five o'clock a dilated capillary filled with the so-called polynuclear round cells. (Rothschild.)

Exceptionally inflammation extends beyond the proper capsule of the gland, involving the tissues lying between the prostate and the rectum, or even the subperitoneal connective tissue. This periprostatitis may be due to rupture of the pus through the glandular capsule, or to transmission of infection through the medium of the veins and lymphatics.

The infiltration may undergo resolution or may suppurate; suppuration is commonly encountered on the posterior surface of the gland,—*i.e.*, between it and the rectum. It may form an abscess completely surrounding the vasa deferentia and the seminal vesicles without exhibiting any tendency to rupture into them.

The prostatic inflammation may halt at any point in the course indicated above. It may therefore manifest itself in the form of acute hyperæmia and swelling, usually secondary to acute catarrh of the prostatic urethra; in that of acute folliculitis, the inflammation involving the prostatic ducts and their accompanying glands, transforming them into sacs filled with muco-pus; in that of a large destructive abscess due to fusion of the smaller suppurating foci; or the periprostatic tissues may become involved.

Symptoms.—The symptoms of prostatitis vary in accordance with the form and severity of the attack. In the mildest form, characterized by acute congestion, there are feelings of weight in the perineum, shooting pains, frequency of urination, and possibly difficulty in starting the stream and failure to experience complete relief after the bladder is apparently empty, pain on defecation, and tenderness and enlargment. When inflammation is more pronounced, the symptoms already noted are increased in severity; there is often the sensation as though a foreign body were stuffed in the rectum; urination is frequent and urgent; a small stream is passed without force, and often intermittently, and the pain is severe. When there is abscess-formation in or about the gland both local and general symptoms are usually pronounced. There is constant pain in the perineum, aggravated by urination, defecation, or motion of any kind; sitting down or crossing the legs is particularly painful. There is a constant, urgent, wearing desire to urinate, each act of micturition voiding a small forceless stream. Defecation may cause great anguish. Intermittent urethral discharge is characteristic. Painful erections are frequently observed. Rigors or chills, followed by fever and headache, are nearly constant. As the swelling becomes greater, urination is correspondingly more difficult, until finally complete retention may result. Hemorrhoids often develop, caused by pelvic congestion, or possibly by the constant straining efforts at urination which prostatitis often occasions.

Diagnosis.—The diagnosis of acute prostatitis is founded on the detection by rectal palpation of a hot, tender tumor occupying the position of the prostate. This, in conjunction with some or all of the above symptoms, and especially with fever and with pain which is especially severe during defecation and at the end of urination, is sufficient to establish the diagnosis.

Prognosis.—The prognosis of acute prostatic congestion, in the absence of infection, is extremely favorable; even when there has been infection, provided the urethra is free from abnormal narrowing and there is no local or general cause for chronic congestion, recovery is the rule. When follicular or parenchymatous suppuration has taken place, the prognosis is still favorable, although there is always danger of septic phlebitis. The glandular abscesses commonly rupture into the urethra, and this is considered a favorable termination. So far as relief of immediate symptoms is concerned, this is undoubtedly correct; but when the abscesses are of considerable size this termination is less favorable, since there is often left a pouch or cavity which will continue to suppurate indefinitely, thus maintaining a condition of chronic prostatitis. In such a pouch urine lodges and may form calculi, which ultimately burrow through the prostate and cause uro-purulent infiltrations of the surrounding tissues or fistulæ.

Acute parenchymatous prostatitis characterized by rapid, purulent breaking down of the entire gland may result fatally. About half these cases rupture into the urethra.

The ordinary directions of pointing are towards the urethra, the rectum, and the perineum. The pus may exceptionally point in the inguinal or the obturator region; with extreme rarity in the space of Retzius, in the peritoneal cavity, or through the sciatic foramen. The opening of such abscesses into the recto-vesical space is usually attended with the formation of multiple fistulæ, which are difficult to cure. Ransohoff notes that of sixty-seven cases twenty-one opened into both the rectum and the urethra. The resultant fistula may be difficult to cure.

Segond calls attention to the frequency of phlebitis when prostatic abscess is not properly drained. About forty per cent. of the deaths are due to this cause. He reports the total mortality as thirty-four in one hundred and fourteen cases. This is not to be accepted as the usual result.

Treatment.—The treatment of acute prostatitis consists in rest in bed, elevation of the pelvis, counter-irritation or local depletion, followed by hot fomentations, a prolonged hot bath, hot or cold rectal douches (Fig. 203), or ice-bags, the use of opium and belladonna suppositories, the internal admin-

FIG. 203.—Rectal irrigator.

istration of urinary antiseptics and bromides, and the ingestion of large quantities of water.

The diet should consist principally of milk, if it habitually agrees with the patient. Hot hip-baths or hot general baths markedly diminish the pain and tenesmus, and may be administered several times a day, the patient being subsequently well wrapped up. The temperature of the water should be at least 105° F. In the beginning of the attack the bowels should be freely opened by salines. After this there should be no effort to procure evacuation for several days, unless there is reason to believe that the rectum is filled with fæcal matter.

The most troublesome complication is retention of urine. This is overcome by the introduction of a soft catheter under efficient local anæsthesia. When this is especially difficult or painful there should be given a general anæsthetic, and an instrument having once been introduced should be left in place until the acute symptoms have subsided.

When an abscess opens into the urethra spontaneously or as the result of catheterization, on the subsidence of acute symptoms every effort should be made to cause cicatrization of the cavity. If this is small, spontaneous healing often takes place. If it is large, suppuration continues, kept up in a measure by the urine, which, lying in this sac, decomposes, becomes irritating, and may deposit calculi. The tendency of this ulcerating sac is towards gradual extension,

destroying the proper capsule of the prostate and causing periprostatic abscess and extravasation of urine. Obstinate fistulæ are likely to form as the ultimate result of these untreated abscess-cavities.

As soon as the acute inflammatory symptoms have subsided, the suppurating cavity should be washed out twice daily. This is accomplished as follows: By means of a finger introduced into the rectum the prostate is well milked and the abscess emptied of its pus. The patient is then directed to urinate, and the urethra and bladder are irrigated with an antiseptic solution; boric acid or silver nitrate answers well. The prostate is again milked, and the patient evacuates that portion of the irrigating fluid which has entered the bladder. This is repeated two or three times at each treatment.

When there is no tendency towards the spontaneous evacuation of the abscess through the urethra, and the chills, fever, and throbbing pain in the perineum persist, and there is marked increase in the swelling, the pus should be evacuated by perineal incision. There should be no hesitation under these circumstances in performing the operation, since, unless the abscess ruptures into the urethra, it is liable to burst through the capsule of the gland, and infiltrate the deep pelvic tissues. The operation should be conducted under an anæsthetic, the prostate being exposed by a semilunar incision in front of the rectum, deepened by gradual dissection. The focus of suppuration may then be detected by the exploring needle. When the tumor is obviously fluctuating it may be opened by a long, straight bistoury thrust in the middle line of the perineum directly in front of the rectum, with its back towards this structure and guided towards the abscess by a finger introduced through the anus, or the skin and superficial tissues may be incised as in the operation of lateral lithotomy, and the wound deepened by means of a hæmostat or similar blunt instrument thrust through the tissues into the prostate under the guidance of a finger inserted into the rectum, with less danger of injuring the rectum or urethra than when the median incision is employed. After opening the abscess the cavity should be drained either by gauze packing or by tubes. Urethral fistula occasionally follows, but usually closes spontaneously.

The treatment of periprostatitis and periprostatic abscess is the same as that described as applicable to prostatitis. The pus is apt to point in the posterior or anal perineum and to invade the ischiorectal space, inasmuch as its origin is behind the middle perineal fascia.

Chronic Prostatitis

Following an acute attack of prostatitis, or secondary to posterior urethritis or cystitis without a history of an acute attack, the prostate may become chronically inflamed. The exciting cause is infection; the predisposing cause congestion. This congestion may be due to long-continued ungratified excitement, excessive coitus, masturbation, hemorrhoids, habitual constipation, irritating conditions of the urine, or any of the conditions which have already been mentioned as causing pelvic engorgement.

The pathology of the affection varies. There is practically always chronic posterior urethritis. Associated with this there may be a catarrhal condition

of the prostatic glands, attended by distinct dilatation of their ducts and acini and marked thickening of the peri-glandular tissue (Fig. 204), or there may be one or many abscesses discharging into the prostatic urethra through openings insufficient for thorough drainage. These are attended by general engorgement, and ultimately result in the development of fistulæ, or in cicatricial deformity or atrophy of the prostate.

Symptoms.—The symptoms of chronic prostatitis may be of a genital or urinary character, or the disease may manifest itself by painful impulses referred to more or less distant regions of the body.

Symptoms of a genital character are of most frequent occurrence, and usually indicate a condition of hyperirritability of the sexual centres, though less frequently cases are encountered in which responsiveness is below the normal; thus premature ejaculation is the most common symptom of this group. Other genital symptoms are prostatorrhœa, imperfection or absence of erections, diminished vigor of erections, frequent nocturnal emissions, and painful ejaculations.

Fig. 204.—Chronic prostatitis. The prostatic glands and ducts are distended with inflammatory products; the acinal epithelial cells have completely desquamated; the surrounding fibrous stroma is dense and thick.

The most frequent single symptom of chronic prostatitis is frequency of urination. Pain during the act, and urgency of desire, are also common complaints, so that the picture presented differs but little from that of acute or subacute posterior urethritis. On the other hand, the symptomatology may indicate a mechanical interference with the performance of the act, the patient complaining of slow or difficult urination, dribbling, or of inability to completely empty the bladder, as in prostatic hypertrophy. The two types of urinary symptoms are probably due to the influence of the inflamed gland on the urethra which it encircles, and to the morphological changes produced by the development of fibrous tissue, or possibly by interference with the coördination of the urethral muscles.

The rich nerve supply of the prostate, fibres coming from the thoracic, lumbar, and sacral segments of the cord, is probably responsible for the large number of locations in which pain may be felt as a result of prostatic disease. The lumbar region, the sacro-iliac articulation, the perineum, the urethra, especially just back of the meatus, the rectum, the testicles, and the thighs, especially their posterior and outer surfaces, are examples of the sites of reflex pain. Usually the pain is a steady ache, but occasionally it has a spasmodic character, so that it has been mistaken for the pain of ureteral colic.

Prostatitis may also produce certain toxic manifestations, incident to the absorption of the products of inflammation, characterized by the production of arthritic pains, or by the development of a distinct neurasthenia, hypochondriac symptoms usually being a prominent feature.

Diagnosis.—The character of the prostate as determined by rectal palpation, and especially the microscopic appearance of the expressed secretion, are relied upon in making a diagnosis of this condition. To the palpating finger the gland may appear either enlarged or diminished in size, the former being the more frequent condition, while the consistency is less uniform and harder. In place of the normal smooth surface a nodular condition is often found. As a result of periprostatic inflammation, the gland may seem to extend upward and outward a greater distance than is normally the case.

The secretion of the prostate is secured by massaging the organ as described in the section on treatment of prostatitis, collecting it as it appears at the meatus, or recovering it by means of the centrifuge from fluid voided after massage. The prostatic secretion should contain but very few leucocytes, so

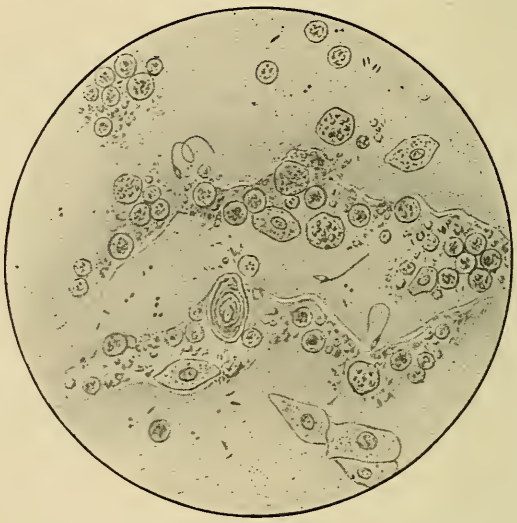


Fig. 205.—Secretion from case of chronic infection of the vesicles and prostate. Note large masses of pus, numerous microörganisms, and few degenerated spermatozoa. Urethral epithelium is also present.

that the presence of more than one or two pus-cells to the field (1/6 inch objective) is an indication of the presence of prostatitis (Figs. 205 and 206), provided the presence of pus from other sources has been rendered unlikely by careful irrigation of the urethra and bladder, and by avoidance of pressure on the vesicles during the massage. The normal prostatic secretion is an opalescent, homogeneous fluid, alkaline to litmus but acid to phenolphthalein. Under the microscope it has a somewhat granular consistence, due to the presence of lecithin bodies, with a small number of round cells with large nuclei from the prostatic tubules, and a very few leucocytes and amyloid bodies with concentric striations. Flat cells from the urethra may also be observed.

Prognosis.—In chronic prostatitis the lesions of which are mainly congestive, with follicular catarrh not yet having developed to distinct abscess-formation, there is a tendency towards spontaneous cure. Small abscess-cavities also heal. The larger sacs show no such tendency. They are rather inclined

slowly to extend, causing periprostatic abscess and urethro-rectal or urethro-perineal fistulæ, often complicated by calculi. In cases characterized by symptoms so slight as to excite no attention, the condition may remain latent, though slowly progressive for years, causing untimately the atrophied prostate and sclerosed and contracted internal vesical sphincter which induce the most inveterate forms of prostatism.

Treatment.—On beginning the treatment of chronic prostatitis the patient should be informed that cure is slow and difficult and is dependent upon persistence in the use of appropriate therapeutic measures and faithful observance of the laws of health. General directions are given in regard to diet, exercise, and hours of sleep. The urine is rendered bland and slightly antiseptic. The bowels are regulated by enemata or paraffin oil; erotic excitement is to be

FIG. 206.—Secretion of acute prostatitis. Vesicular secretion is also present.

avoided, though ordinary sexual intercourse need not be forbidden. It is undoubtedly true that many cases of chronic prostatitis would be cured by hygiene alone if it included regular and unemotional sexual gratification. Unfortunately, the majority of these patients are young, unmarried adults, and, even if the question of morals were set aside, it would not be possible for them to secure sexual relations that would meet their requirements. Hip-baths of a temperature and duration governed by the sensations of the patient are useful. Rectal lavage with hot or cold normal saline solution should be used daily. The use of the cold jet by means of the bidet is markedly beneficial in many cases.

Digital massage of the prostate is the most valuable single procedure at our command, its virtue lying in the expression of the morbific contents of the gland and in the ensuing betterment in the circulation of the blood and lymph. For the treatment the patient should stand with his feet apart, knees straight, bending forward from the hips so that the trunk is at right angles with the thighs,

the hands being placed on the seat of a chair. The surgeon should sit behind and a little to the left of the patient, and should have the forefinger of his right hand protected by a rubber finger cot and thoroughly lubricated. In introducing the finger care should be taken to avoid the anal hairs, to follow the direction of the canal (first toward the umbilicus, and then backward along the sacrum), and to make all movements slowly, steadily, and without force.

After ascertaining the size and general conformation of the organ by gently sweeping the finger over it, the massage is applied by making pressure upon various portions, starting above and at the outer sides, and gradually working downward and toward the midline. When difficulty is experienced in reaching the upper portion of the gland it will be found helpful to rest the elbow on the right knee, placing the foot on the round of a chair if necessary to bring the knee to the proper height, making pressure with the muscles of the hip rather than with those of the shoulder. Making pressure downward with the left hand on the bladder through the abdominal wall is also helpful in some cases.

Massage should be immediately followed by the voiding of the four to six ounces of urine of other fluid which should be in the bladder during the treatment, and an irrigation of the urethra and bladder by hydrostatic pressure to free them from prostatic secretion.

Prostatic massage may also be administered with the aid of mechanical vibrators by applying the instrument to the knuckle of the palpating finger.

The interval between treatments should be from three to ten days. It is applicable whether pus-cavities are present, or whether there is merely a catarrhal inflammation. The massage should not be painful, and should be followed by a feeling of added comfort.

Local applications to the prostatic urethra are generally indicated for the relief of the accompanying posterior urethritis. These are selected and applied in accordance with the principles already laid down, but should be used cautiously, since reactionary swelling may entirely close the urethral opening of a chronic abscess, causing retention of pus, extension of parenchymatous inflammation, and septic absorption. If the reaction following the use of weak instillations is unusually prolonged and severe they should be discontinued.

The treatment of urinary retention, with its painful complications and fatal sequelæ dependent on sclerosis of the internal vesical sphincter secondary to chronic prostatitis, requires overdilatation or section of the obstructing ring. Prostatectomy, though often performed for the relief of this condition, is not indicated.

IRRITABLE PROSTATE

This is a condition characterized by repeated rather sudden and acute engorgements of the prostate, usually dependent upon an abnormal condition of the urine, such as excessive acidity, and is usually associated with arteriosclerosis. The attack is often precipitated by surface chilling, exhaustion, constipation, or by alcoholic or sexual excess. It is probable that it does not attack the perfectly healthy prostate. It has been so often observed in gouty patients that the manifestations of this form of irritability are in them called prostatic gout.

The symptoms are those of the first stage of acute prostatitis. There develops often in the night urgent, frequent, painful urination. There may be steady or shooting pain felt in the perineum, testicles, or back. On rectal examination the prostate is hypersensitive. In gouty patients the urine is extremely acid and contains an excess of mucus. The symptoms attain their maximum severity during the night, and the prostate remains sensitive for some time. This condition of irritability may be the first step in the development of cystitis or calculus-formation.

Diagnosis.—An irritable prostate is distinguished from an inflamed gland by rectal palpation and examination of the urine. Inflammation is always accompanied by the formation of pus and by marked increase in the size of the prostate. The diagnosis of prostatic gout depends upon the constitutional history of the patient and examination of the urine.

Treatment.—The irritable prostate is amenable to treatment directed to the relief of congestion. A prolonged hot bath, free emptying of the lower bowel by a hot soapsuds enema, and a hypodermic injection of morphine best control the acute attack. Acid or irritating conditions of the urine should be remedied, sexual excess, constipation, and the well-recognized causes of pelvic congestion should be avoided, and the prostatic circulation should be strengthened by massage, hot rectal injections, and the application of electricity. The medicinal treatment is directed to the equalization of circulation and the general strengthening of the patient. Hyoscyamine sulphate (grain $^{1}/_{200}$) by mouth twice a day seems to be helpful.

TUBERCULOSIS OF THE PROSTATE

Tuberculosis may be primarily in the prostate or secondary to involvement of organs either adjacent or remote. The proportion of cases in which the disease is primary in the prostate is not known, since there have been few opportunities offered for postmortem examination until tuberculosis has been widely diffused. There have, however, been a sufficient number to prove that the first manifestation of the disease may appear in the prostate gland. This gland is particularly susceptible to infection of all kinds, Weigert having proved that it is involved in the majority of cases of pyæmia and septicæmia. Tubercle bacilli have been found in the apparently healthy prostate.

Tuberculous prostatitis is commonest in the prime of life. It is often predisposed of by posterior urethritis; at least the histories of many of these cases show that tuberculous involvement followed gonorrhœa. It is evident that any of the causes of prostatic congestion may thus predispose to the local development of tuberculosis. The morbid anatomy of tuberculous prostatitis is that characteristic of tuberculous involvement in general—*i.e.*, exuberant granulation, central degeneration, and caseation. The tubercles are first lodged in the walls of the glandular ducts, extending through a part or the whole of the gland, and ultimately either undergoing encapsulation or absorption, a rare termination, or softening and breaking down, forming abscess-cavities.

The prostate is usually enlarged from inflammatory congestion; abscess-formation takes place slowly but surely. Exceptionally the lesions develop in the lower outer portion of the gland near the rectum; usually they are observed

near the urethra. In this case ulcers are formed which steadily extend. Abscesses developing in the substance of the gland, though occasionally sclerosing and healing, commonly enlarge steadily, opening into the urethra, the rectum, the perineum, or even the hypogastrium, and forming multiple fistulous tracts. Tuberculosis of the prostate becomes generalized slowly. Usually a mixed infection supervenes, the colon bacillus and the various staphylococci being the organisms generally present.

Symptoms.—The symptoms of tuberculous infiltration of the prostate are practically those of chronic prostatitis, and are probably dependent upon involvement, or at least secondary congestion, of the prostatic urethra. The patient complains of frequent, often urgent, urination, and a slight continuous or intermittent, glairy, mucopurulent discharge from the meatus. Shreds are constant in the urine; there may be a discharge after defecation or even after each act of urination; somtimes one or two drops of blood are passed at the end of urination, and attacks of acute or subacute prostatitis are excited by slight and apparently insufficient causes. When the parenchymatous or peripheral portion of the gland is involved there may be no symptoms for a long time, or the patient may note slight pain during defecation and burning pain afterwards. In certain cases the disease appears to begin as an acute parenchymatous prostatitis. On the subsidence of the early inflammatory symptoms nodulation may be felt.

Diagnosis.—This is based on finding the tubercle bacilli in the discharge milked from the prostate, on the detection of thickening, nodulation, or points of softening on rectal examination, and on the discovery of tuberculous involvement of the epididymis or the seminal vesicles. The infiltration sometimes spreads wide of the prostate, forming a large, irregular, diffuse mass entirely obscuring the outlines of the prostate and vesicles. The tuberculin test is often of assistance.

Prognosis.—This is grave. Spontaneous cure by a process of sclerosis, though possible, is rare.

Treatment.—The treatment should be directed towards improving the general health of the patient, and is practically that appropriate to pulmonary tuberculosis. Therapeutic injections of tuberculin should be carefully employed. As a rule, local instrumentation and applications should be avoided, with the exception of instillations of mercuric bichloride (1 to 6000). These may be employed as directed in the treatment of tuberculous cystitis, and are serviceable only when the infiltration begins in the urethra or in the ducts of the glands. Silver nitrate is particularly to be avoided.

In conducting local treatment it must be remembered that tuberculous infiltration especially predisposes the involved portions of the prostate, and the bladder, which also often shows tuberculous lesions, to the invasion of the ordinary pus microörganisms: hence special antiseptic precautions should be taken in the use of instruments.

Incision is indicated when an abscess develops which threatens to form a fistula. The prostate should be fully exposed by the semilunar incision in front of the anus, and all the diseased tissue should be removed by the curette, the urethra not being opened if it is possible to avoid this. The wound is

treated by packing with iodoform gauze. Abscesses opening into the urethra are kept clean by irrigation. Retention of urine is relieved by continuous catheterization or suprapubic drainage.

HYPERTROPHY OF THE PROSTATE

Hypertrophy of the prostate consists in an overgrowth of the normal cellular constituents of the gland taking place in one or more of its lobes. At the beginning of the overgrowth the change in form is best expressed by what Thompson calls an unnatural tendency to rotundity. The gland is increased in thickness rather than in other dimensions, the lateral lobes encroaching to some extent upon the urethral lumen. If the enlargement is progressive it is likely to be somewhat irregular, certain portions of the gland increasing more rapidly than others. The bulk of the hypertrophy may be in the median or either of the lateral lobes, or in any combination of these (Figs. 207, 208, 209, and 210). Enlargements of the median lobe are probably not as common as has been supposed, many of the obstructive growths lying in the midline having their origin in the subcervical glands of Albarran and in the subtrigonal group, as pointed out by Lowsley. Hypertrophy of the anterior lobe is very rare. In fact, Taudler and Zuckerkandl, basing their opinion on extensive and careful anatomical studies, have recently claimed that the hypertrophy of the gland always begins strictly in the middle lobe or that portion of gland between the urethra and ejaculatory ducts.

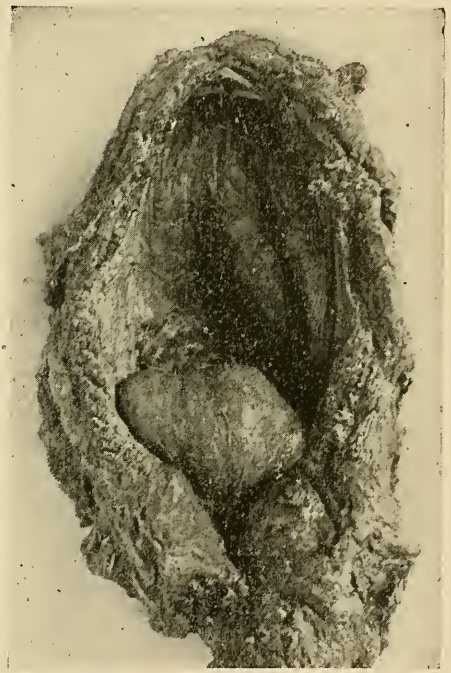


FIG. 207.—Hypertrophy of median lobe of the prostate. (From the Department of Surgical Pathology, University of Pennsylvania.)

In its overgrowth the prostate may be greatly enlarged and soft, indicating a preponderance of glandular overgrowth, glandular hypertrophy (Fig. 211); may be moderately enlarged, or even small and hard, suggesting an excessive stromal proliferation, particularly of the connective-tissue elements, fibromuscular hypertrophy, or may represent a combination of these two types. In the majority of cases in which both glandular and fibromuscular increases are present the glandular tissue is in excess. The hypertrophy usually takes the form of spheroids within the lobes, growing progressively, and gradually compressing the remaining prostatic tissue, which forms a capsule about the enlarging portion, within which enucleation may be performed. The spheroids are less marked in fibromuscular enlargements, and in a form of diffuse glandular hypertrophy sometimes encountered. In such cases enucleation is therefore

much more difficult, as the line of cleavage is not so distinct, the prostate having to be separated from its capsule.

The direction of growth may be towards the bladder, the urethra, or the rectum. When the overgrowth is limited to the middle lobe, a projecting intra-urethral or intracystic sessile or pedunculated mass is formed (bar at the neck of the bladder), which may seriously interfere with urination. The anterior commissure (isthmus) is only exceptionally involved. Hypertrophy commonly

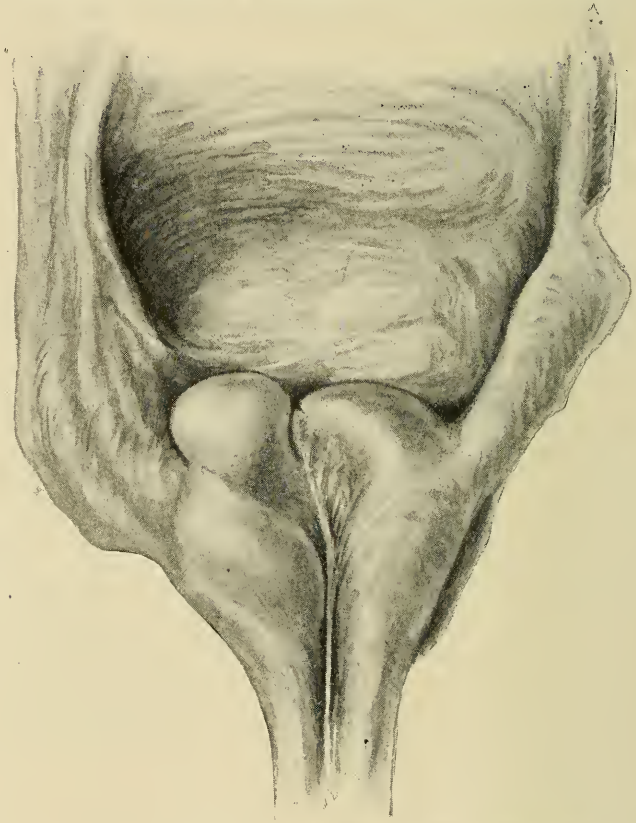


FIG. 208.—Hypertrophy of the left lateral and median lobes of the prostate, causing trabecular hypertrophy and dilatation of the bladder. (Museum of Pathology, University of Pennsylvania.)

involves the three lobes and is progressive, though somewhat unevenly, in all. Its projection upward and backward is incident to lessened resistance, the fascial investment limiting its downward and forward growth.

As to the amount of overgrowth, this varies within wide limits. The tumor may be little larger than normal, or may reach the size of an orange or even of a cocoanut.

Far more important than the position and size of the growth are the alterations it causes in the length, direction, and calibre of the prostatic urethra, and in the patulousness of the neck of the bladder. In consequence of the

increase in thickness and the upward and backward growth of the lateral lobes, the transverse diameter of the urethra is lessened, and its length is increased in some cases by as much as three and one-half inches. If the growth is asymmetrical, the canal will be deflected from its regular curve. Thus, if the median portion enlarges more rapidly than the lateral lobes the floor of the urethra is lifted up, forming an abrupt projection, which effectually prevents the introduction of the ordinary silver catheter. When one lateral lobe is developed more than another there is lateral deviation, with the concavity of the curve towards the most affected side.

FIG. 209.—Hypertrophy of the median and one lateral lobe of the prostate. *a*, interureteral bar. (Watson.)

The posterior commissure growing backward into the bladder may become pedicled, forming a true valve; commonly it is sessile. The lateral lobes may project backward about the vesical neck in the form of multiple tumors which encroach upon the vesical cavity and lift the neck above the level of the base, forming two vesical pouches, one above and in front, behind the pubic, the other below the prostate in the bas-fond. The lower pouch is usually caused by overgrowth of the median lobe. Between the ureters there is normally an interureteral bar, made up of muscular fibres, not distinguishable, except by dissection, in the normal bladder; this bar becomes greatly hypertrophied in enlarged prostate because of the frequent straining efforts to expel urine from the region in which it is apt to accumulate and cause irritation.

Pathology.—Section of an enlarged prostate shows upon examination a series of projecting spherical lobulations which can be readily shelled out from the surrounding tissues. These fibro-adenomatous masses vary from the size

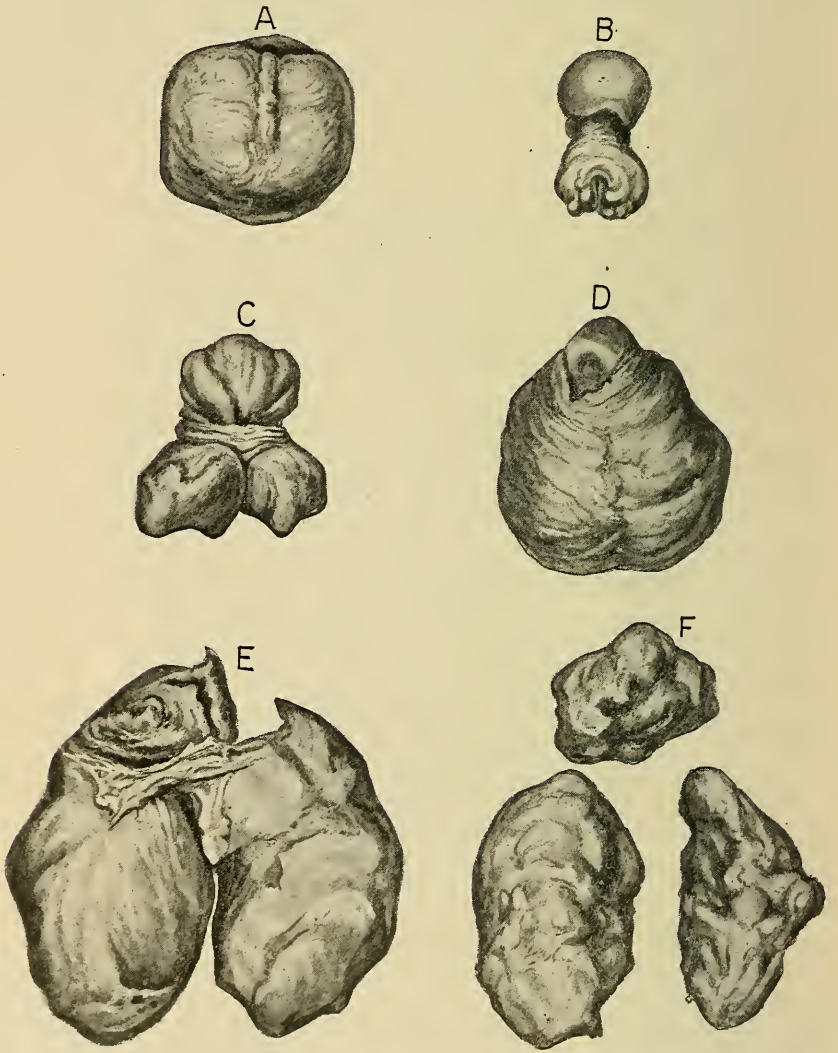


Fig. 210.—Various forms of hypertrophy of the prostate. A, slight symmetrical enlargement of lateral lobes; B, hypertrophy of median lobe only; C, moderate hypertrophy of both lateral and middle lobes; D, hypertrophy of lateral and valvular type "enlargement of median lobe;" E, excessive enlargement of lateral lobes; F, excessive hypertrophy of both lateral and median lobes.

of a pea to that of an egg, and represent overgrown lobules, each with its fibro-muscular investment and glandular centre.

The chief characteristic of a microscopic section from the average enlarged prostate is glandular hyperplasia. The ducts and acini may be dilated, and

the latter coalescent, and lined with either a single layer of epithelium or so filled with cells as to simulate cancer. Malignant degeneration of an enlarged prostate has been frequently observed by Albarran, and when the epithelial cells are observed breaking through the basement membrane and infiltrating the stroma the diagnosis of beginning cancer can be made with some certainty.

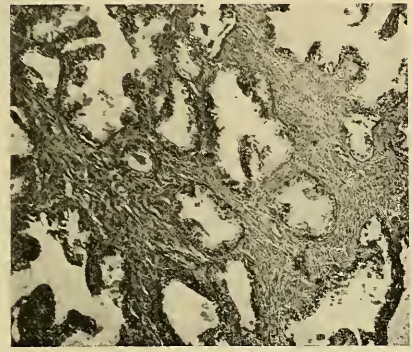


FIG. 211—Glandular hypertrophy of the prostate.

FIG. 212—Prostatic hypertrophy. Acini filled with desquamated epithelial cells and corpora amylacea.

The epithelial lining of both the ducts and acini may entirely disappear, and the latter may be represented by fibrous tissue. The acini are at times distended with inflammatory products, forming multiple chronic abscesses in the substance of the gland, or they may be filled with their own secretion (Fig. 212), which exhibits a tendency to form concretions.

The stromal outgrowth is usually made up of an increase in connective tissue, the smooth muscular fibres exhibiting a tendency to disappear, though true myomatous overgrowths have been observed. There are scattered through it areas of round cell infiltrate, suggesting inflammation (Fig. 213).

FIG. 213.—Hypertrophy of the prostate. Showing acinus surrounded by marked round-celled infiltration.

There is no evidence to show that the small hard prostate is a secondary stage of the large soft enlargement, nor that the type characterized by gland hyperplasia becomes ultimately converted into the form which exhibits predominance of fibroid tissue. Each form seems to begin and to progress independently. The pathological changes in the bladder, ureters, and kidneys, incident to prostatic outgrowth (Figs. 214 and 215), are those incident to obstruction in old men, whose bladders are undergoing muscular degeneration and have already been described. (See page 60.) They lead inevitably to renal insufficiency, the terminal stage of which is usually heralded by a rapid gastro-intestinal breakdown.

Etiology.—The evidence derived from the more recent pathological studies of the prostate gland points somewhat to the dependence of this condition upon chronic inflammation which remains latent, in so far as symptoms are concerned. Irregularly distributed through the stroma there is practically always a round cell infiltration, most marked about the urethra; in the stroma surrounding the ducts and acini are seen either fibroblasts or true cicatrices.

Against the inflammatory theory of prostatic enlargement it may be said that it is a disease of declining years, having been rarely observed before the age of forty-five, that no relation can be traced between its development and a

Fig. 214.—Prostatic obstruction with hypertrophy of the bladder-wall and contraction of its cavity. (Specimen in Museum of Philadelphia Hospital.)

history of preceding acute or chronic prostatitis, that thirty-three per cent. of men above sixty show some evidence of enlargement, and that the prostates of practically all men past middle age are shown on microscopical study to be subject to the same adenomatous change which in its more complete development is called prostatic hypertrophy.

The dependence of prostatic enlargement upon general atheroma remains to be proved, though it is undoubtedly true that these two elements are often associated and are common at the same period of life.

There is a variety of overgrowth in which the prostate becomes hard, showing little alteration in shape or size, but giving rise to marked obstruction which may have for its cause a general sclerosis, though it is more probably due to fibroid degeneration following chronic inflammation.

Symptoms.—The symptoms of enlarged prostate are mainly dependent upon interference with the function of micturition: hence it is possible, when the overgrowth occupies such a position in the gland as not to interfere with the calibre, dilatability, or direction of the urethra, that it may attain large proportions before any symptoms are excited. As soon as the tumor grows in such a direction or reaches such size that the urethral calibre is distinctly encroached upon, the patient will notice that—(1) Micturition is unduly frequent, this frequency being most marked during the night or in the early morning. (2) There is some delay in starting the stream, and this does not flow with its wonted force, falling almost directly from the penis without the customary parabolic curve. (3) There is a tendency to dribble on the completion of the act of micturition.

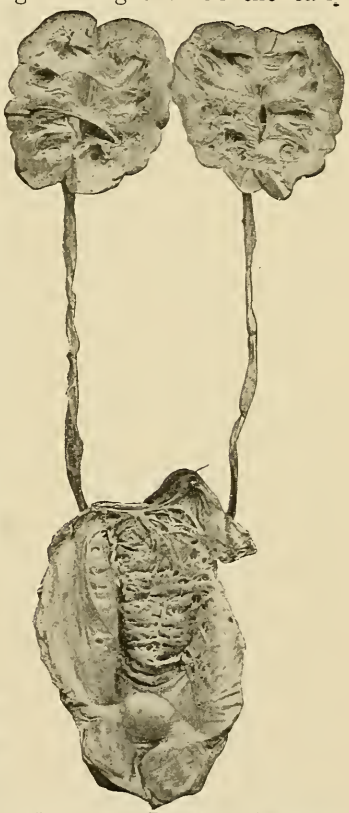


Fig. 215.—Prostatic obstruction. Effect on bladder and kidneys. (Specimen in Museum of Philadelphia Hospital.)

Provided infection does not take place, with the development of posterior urethritis and cystitis, these may be the only symptoms of which the patient complains until the distention of the bladder reaches such a point that incontinence of retention develops. As a rule, long before this there are set up a certain amount of urethritis and cystitis. There are then added to the obstructive symptoms—*i.e.*, frequency, most marked at night, slowness in starting the stream, loss of force, and dribbling—the symptoms of inflammation. These may appear in the form of a sensation of weight, of a weak and tired feeling, of an ache which may be steady or intermittent, or sharp or dull pains may be felt in the perineum, scrotum, hypogastric region, groins, inner surfaces of the thighs, back, and testicles. Later there are pains above the pubis and sharp, shooting pains in the urethra behind the glans penis. Urination becomes excessively frequent and painful, is attended with violent straining, and is suddenly and frequently interrupted; the stream is small and broken. The urine becomes alkaline and offensive, is turbid with pus and mucus, and there is often a muco-purulent urethral discharge.

Frequency of urination in cases with non-infected bladders is due to residual urine. This occupies the space that should be taken up by fresh secretion from the kidneys, and hence causes the bladder to become distended sooner than would be the case normally. The amount of residual urine is proportionate to the degree of obstruction, and as it increases in quantity it causes gradual distention of the bladder-walls, with atrophy and degeneration of the vesical muscles, nearly always preceded by hypertrophy incident to the efforts made to overcome resistance.

The frequency of urination in the absence of inflammation is proportionate to the degree of vesical distention. This symptom is especially distressing because it is most pronounced during the night, in advanced cases compelling the patient to rise every half-hour. Nocturnal frequency has been ascribed to the more irritating nature of the urine secreted at night and to the increase in the quantity secreted. This may be true in part, but it may be doubted if urination is really much more frequent in the night than in the day. All night disturbances make a much deeper impression than those by day, and anxiety exaggerates a few disturbances into a constant series. It must be borne in mind that when the patient micturates once during the night it is significant, and the gravity of this significance increases with the frequency of the act.

Residual urine, and hence frequent urination, are more marked and earlier symptoms when there is hypertrophy projecting backward from the median portion of the prostate. Owing to the altered relation produced by the overgrowth of the neck of the bladder, a pouch is formed about the outlet. In this a certain amount of urine is contained which the bladder musculature is unable to expel. This pouch increases in size as the bladder becomes distended, until a condition of chronic tension is reached, characterized by incontinence, which in elderly men is nearly always indicative of retention.

Loss of force in the stream is due in part to atony and degeneration of the bladder-muscles, in part to the urethral obstruction. Slowness in starting micturition and dribbling on the completion of the act are caused partly by the atony, partly by reflex spasm of the compressor urethræ muscle.

Very exceptionally complete retention of urine is an early symptom of hypertrophy. It is then an expression of acute congestion incident to excess, exposure to cold, etc. In the later stage of the affection it is due to permanent overgrowth. As a result of vesical and renal retention there is always polyuria, the urine being of low specific gravity. This hypersecretion of urine is one cause of frequency, and this fact should be remembered in estimating the bladder-capacity and the significance of frequent urination.

As the disease progresses, in consequence of severe straining, hemorrhoids, rectal prolapse, or abdominal hernia may develop. Ultimately, if the obstruction is untreated, there will be dilatation of the ureters and kidney pelves, and in infected cases the development of pyelonephritis and uræmic poisoning.

Exceptionally there is bleeding. This may be severe and spontaneous, in which case there is usually relief of symptoms. It is commonly due to instrumentation. Calculus not infrequently develops.

It is evident that the symptoms of enlarged prostate are those of obstruction to the passage of urine, to which are ordinarily added symptoms of inflammation. The obstructive symptoms are comparatively painless, and are slowly progressive; they ultimately bring about changes in the upper urinary tract, which lead to increasing renal insufficiency. Inflammation converts this slow, painless disease into one that is extremely painful, is often rapid in its course, and is immediately threatening to life. From this consideration the importance of strict cleanliness in dealing with cases of enlarged prostate is evident.

Diagnosis.—In the presence of the symptoms of prostatic obstruction in a man over fifty-five years of age—*i.e.*, a feeble stream started with difficulty,

frequent urination, most marked at night, and a feeling as though the bladder were not completely emptied,—a positive diagnosis may be made by direct examination.

The first step in this direction consists in the introduction of a finger into the rectum.

The patient standing with his legs apart and leaning forward, his hands upon a table or chair, the index-finger protected by a cot is introduced through the sphincter, and an effort is made to feel the base of the prostate. As the finger is entered more deeply the lateral outlines of the gland are explored, and its density, the irregularities of its surface, finally the height to which it reaches, are noted, the finger being carried on until the soft bladder can be felt above the upper border of the prostate. In these subjects bimanual palpation is distinctly serviceable. It will be remembered that the normal prostate is about the size of a horse-chestnut, is often cordate in shape, with the base upward towards the bladder, is not very sensitive to pressure, and can be clearly outlined by rectal palpation. Above it the bladder-wall can be felt.

The next step in direct examination consists in the introduction of urethral instruments. This will enable the surgeon to determine the extent to which the prostatic portion of the canal has been lengthened, the thickness of the gland, the presence of lateral deviations, the position and extent of an obstruction placed at the neck of bladder, and the amount of residual urine.

In considering the advisability of the passage of instruments in a given case, it must be recognized that the chronic obstruction reduces the normal resistance of the bladder and kidneys to infection, and that the great majority of those which have uninfected urine prior to the passage of an instrument will become infected at the first passage of a catheter, and if not at the first, then at a comparatively early period in its use, and this in spite of the most skilful manipulation and the most careful asepsis; and this infection involves not only the bladder, but the ureters and renal pelves as well. Because of this, the patients who come to the surgeon with bladders already infected as a class are more easily managed than those who come with sterile urine, for their tissues have established a certain tolerance to infection, and for this reason they stand instrumentation better and run a smoother course.

It is therefore proper in the case of patients with urine containing pus to proceed without hesitation to procure such information as seems desirable by means of careful urethral instrumentation; but in the case of patients whose bladders are as yet uninfected some hesitation may be felt, and the decision made on the intensity of the symptoms presented. If these are of such a nature that interference is evidently demanded, the patient requiring either operative treatment or the institution of catheter life, then it is wise to proceed with the examination, using all possible precautions against infection. If, however, there are obvious reasons why neither of these forms of treatment should be instituted, it is the wiser course to forego all instrumentation.

For the purpose of determining the extent to which the urethra is lengthened, a soft elbowed catheter is employed. Urethral length varies so greatly in individuals that it is impossible to establish a standard which will apply to every case. As a rule, it is safe to conclude that if the catheter has to be passed more

than eight and one-half inches to evacuate the urine from a bladder containing three or four ounces, the prostate is enlarged. A more accurate way of arriving at the length of the prostatic urethra is to determine the length of the anterior urethra by passing an acorn-headed bougie to the anterior layer of the triangular ligament. A catheter is then introduced into the bladder containing but a few ounces, and when urine begins to flow the point on its shaft corresponding to the position of the meatus is marked. When the catheter is withdrawn, measurements are taken from this point to the end of the eye. Subtracting the anterior urethral length from the total length, the remainder represents the length of the prostatic and membranous portions of the canal; three-quarters of an inch can be allowed for the membranous urethra. Should the prostatic urethra be found over one and three-quarter inches long, the diagnosis of enlargement of the prostate is reasonably assured.

Metal instruments are employed to determine the presence of lateral deviations of the prostatic urethra, the thickness of the enlarged gland, and the seat and projection of growths about the neck of the bladder. They should never be grasped tightly when they are introduced. A stone searcher when it can be introduced without the use of undue force is best adapted to the purpose. Pressure should be gentle, and so directed that the instrument may follow any slight irregularities in the direction of the prostatic urethra. It will often happen that before the instrument can be made to enter the bladder the handle must be considerably lateralized, showing deviation of the urethra to one side, or when the middle portion of the prostate is enlarged and projects upward the handle may have to be depressed much more than is usually the case. When the instrument has entered the bladder, palpation against its shaft through the rectum may give an approximate idea of the antero-posterior diameter of the gland. The beak of the instrument is then turned in all directions, and a careful exploration is made for stone, since this is a frequent complication of prostatic enlargement. After exploration of the bladder is completed the instrument is withdrawn until the beak lies just within the internal vesical sphincter. Then, by turning it from side to side, not only can the base of the bladder be explored, but polypoid tumors, which sometimes project about the neck of the bladder, can be distinctly felt. In case of a healthy bladder and prostate, the rotation of this sound when its beak is still within the neck of the bladder is unattended with resistance. If there is marked hypertrophy, and particularly if the middle portion of the prostate is affected, jutting back into the bladder, the beak of the instrument cannot be rotated in this way, but will encounter a resistance from which it can be freed only by greatly depressing the handle. For the purpose of determining by instrumentation which lateral lobe is enlarged, Mercier, after having explored the bladder, withdraws the instrument, keeping its shaft as nearly horizontal as possible as it traverses the prostatic urethra. The shaft of the bougie will be deflected to the side of the greatest enlargement; in cases of symmetrical enlargement there will be no deflection. The most accurate method of determining the manner and extent to which the prostate encroaches on the bladder is by cystoscopy (see p. 47).

The patency of the urethra and the encroachments upon its calibre by prostatic outgrowths are best ascertained by introducing full calibre solid steel instru-

ments, or silver or soft English catheters. If these instruments are arrested at a point more than seven inches from the meatus, the obstruction is in the prostatic urethra. If an instrument with a prostatic curve is arrested at the same point, but on continued pressure passes on into the bladder, often with a distinct jump, and if a Mercier elbowed catheter goes in without difficulty, the obstruction is probably one caused by upward projection of the urethral floor, and its distance from the meatus can be measured by the solid sounds. If the moderately stiff Mercier catheter will not pass, but a very small gum catheter or one of the rat-tail pattern enters, the urethra is probably deflected to one side or the other. If all instruments enter readily, but the outward flow of urine is decidedly interfered with, the obstruction is valvular.

The amount of residual urine is determined by introducing a catheter after the patient has attempted to empty his bladder, drawing off what remains. Normally no urine should flow through this catheter, or at most a few drops. Measurements of the urethral length can advantageously be made during this portion of the exploration.

The tonicity of the bladder is estimated by the force with which the urine is propelled through the catheter.

Differential Diagnosis.—The differential diagnosis of obstruction from enlarged prostate must be made from that due to stricture, to chronic posterior urethritis, to chronic prostatitis with contracture of the internal vesical sphincter, to calculus, to bladder-tumors, to vesical atony, and to paralysis.

In stricture there is a small stream which often has considerable force; in prostatic obstruction the stream may be large, but is without its normal parabolic curve. Stricture, as a rule, attacks young men; enlarged prostates are chiefly observed in old men. Stricture causes obstruction to the passage of the instruments within six and a half inches of the meatus; the obstruction of enlarged prostate is more than seven inches from the meatus. There is no increase in urethral length in stricture; this is nearly always present in enlarged prostate.

Chronic posterior urethritis is commonly observed in young and middle-aged men, and is often a sequel to gonorrhœa; there is little or no increase in the size of the prostate, by either rectal or urethral examination; there is constantly a small quantity of pus in the urine, and the force of the stream is not markedly diminished, although there may be trouble in starting it and an imperfect cut-off. There is no residual urine.

Chronic prostatitis associated with contracture of the internal vesical sphincter is especially characterized by retention of urine, slowly but persistently progressive and rarely absolute—no prostatic enlargement is found either by rectal palpation or urethral examination—the urethral length may be shorter than normal, and the cystoscope and sound fail to demonstrate irregularities about the bladder neck. This form of prostatitis may or may not be accompanied by the symptoms of chronic posterior urethritis. If obstruction to instrumentation is detected it is found at the internal vesical sphincter.

Vesical calculus is most painful, and causes most marked frequency of urination when the patient is up and about, and the symptoms are markedly alleviated by rest in bed. Usually severe pain and tenesmus, especially if associated with pus and blood in the urine, and if paroxysmally persistent, should always suggest the presence of stone in the bladder. Rectal examination and exploration

of the bladder with stone searcher or cystoscope should at once establish the diagnosis.

Intravesical tumor may closely simulate the symptomatology of enlarged prostate. Hæmaturia is, however, pronounced, and becomes progressively more severe. As a rule, frequency of urination is greater by day in tumor and at night in prostatic hypertrophy. Rectal and cystoscopic examinations will establish the diagnosis.

The diagnosis of hypertrophied prostate from atony or paralysis of the bladder is dependent upon the history of the case and upon exclusion of enlargement of the prostate by rectal and urethral examination.

The clinical classification of cases of prostatic enlargement should be made from the standpoint of the degree of urinary obstruction occasioned by the gland and the presence or absence of vesical infection.

Retention is the symptom of obstruction. This may be acute or chronic, partial or complete. The incomplete chronic retention may or may not be accompanied by vesical distention. Any of these forms of retention may be complicated by infection.

The acute complete retention is usually observed in men who have exhibited symptoms of moderate obstruction and is due to sudden congestion of the prostate. In most of these cases there has been a previous long-standing condition of incomplete retention with or without bladder dilatation.

Chronic complete retention is practically always accompanied by vesical dilatation. In this condition no urine is passed by voluntary effort.

Chronic incomplete retention implies the ability partially to empty the bladder, a residuum being left which may not greatly increase if the bladder-walls become thickened by muscular overgrowth or inflammatory infiltrate and organization, or which may gradually produce enormous distention, the overflow then passing both voluntarily and involuntarily.

Retention, if progressive, inevitably results in vesical atony and distention, and ultimately in interstitial nephritis and renal insufficiency. At times it is accompanied by hemorrhage from the dilated veins of the urethral or vesical mucosa, exceptionally spontaneous, usually provoked by instrumentation. Cystitis, though usually first excited by catheterism, may arise independent of this, and may be secondary to pyelitis or pyelonephritis. Vesical calculus is a common sequel of cystitis and residual urine, and epididymitis is a common complication of catheterism when the bladder and posterior urethra are infected.

Prognosis.—Men of over sixty years commonly enough exhibit a symptom-complex characterized by frequency of urination, especially at night, slowness in starting the urinary stream, intermittence and lack of force in its propulsion, and dribbling at the end. On rectal examination the prostate shows the moderate enlargement common at this time of life. These patients can hold their water comfortably three or four hours; if a residuum be sought for, usually an undesirable procedure, either none or at most a few ounces will be found. This condition is due in part to lack of detrusor force, in part to vasomotor instability and muscular incoördination, and may be so slowly progressive that treatment other than hygienic and circulatory is not indicated.

When, however, the bladder becomes permanently distended, or when cystitis

develops either with or without distention in the presence of residuum, so that frequency and urgency are harassing by night and crippling by day, or when there is the incontinence of overflow, in the absence of surgical intervention death may be predicted in months or at most in a few years, usually from renal insufficiency incident to back pressure and ascending infection.

TREATMENT OF HYPERTROPHY OF THE PROSTATE

PALLIATIVE TREATMENT.—This has for its end the regulation of pelvic circulation in such wise that both active and passive congestion, with their incident, increased obstruction from swelling and spasm, may be avoided. This implies:

1. Careful medicinal, dietetic, and mechanohydropathic regulation of the cardiovascular system.

2. The maintenance of a bland condition of the urine by the drinking of much water, but always short of interfering with digestion.

3. At least once daily a bowel movement, secured by abdominal massage, deep breathing, paraffin oil, and copious enemas of hot normal saline solution; in case of need, senna, cascara, and colocynth are the drugs of choice; always the laxative which the individual has found best suited to his needs is to be employed.

Surfeit, and even the moderate eating of food which is known to disagree, alcohol in excess, surface chilling, cold wet feet, prolonged sexual excitement, withstanding the desire to empty the bladder, constipation, over-fatigue (either physical or mental)—these are conditions which distinctly aggravate prostatic congestion and favor attacks of acute retention.

Horseback and bicycle riding are helpful to some patients, hurtful to others.

Night frequency can be lessened by a hot bath on retiring, the bladder being emptied at this time by a series of easy efforts. In the morning also the urine is to be passed in a similar manner, the patient being instructed to pass without straining as much as practicable on rising; thereafter again when through exercising and " breathing; " again after shaving; again after bathing; again when half dressed; and again when completely dressed.

Medicinal Treatment.—Since many cases of partial retention are due to venous engorgement, drugs which influence the underlying cardiovascular condition are of major importance. A too acid or too alkaline condition of the urine may be temporarily remedied by full doses of sodium bicarbonate or the acid phosphate of sodium. The sphincteric spasm is at times influenced favorably by hyoscyamine sulphate (gr. $^1/_{200}$ twice daily). Saw palmetto and santyl have at times a distinctly beneficial effect upon the vesical tonus.

Intermittent Dilatation.—A patient who presents the symptoms of a prostato-vesical congestion of the early stages of hypertrophy who is disturbed once or twice at night, who has an enlargement of moderate density, appreciable through the rectum, but not offering much resistance to the introduction of an ordinary catheter, and who has but little residual urine, may derive benefit from the systematic introduction of full-sized steel sounds, or the use of a Kollman dilator. The largest steel sound which the membranous urethra will permit to pass is introduced every fifth day, and is allowed to remain in place for ten to fifteen minutes. Preliminary irrigation of the urethra, careful sterili-

zation of the instrument, and gentleness in its introduction lessen the danger of posterior urethritis, cystitis, and ascending infection, but cannot guard completely against them. Since the membranous urethra will not admit an instrument sufficiently large to stretch the internal sphincter, it is probable that the beneficial effect of this treatment is attributable to the traumatic inflammation excited thereby.

Rectal Injections.—These may be hot or cold, as the patient prefers, and may be of normal saline solution when ordinary water congests and irritates the mucous membrane of the rectum. The stream of water should be thrown forcibly upward and forward directly against the prostate, and the injecting-pipe should be provided with openings through which the liquid escapes at once without distending the rectum.

Massage, particularly vibratory massage, is useful, not so much because it causes shrinking of the prostate as because of its tonic effect upon the walls of the blood-vessels, thus diminishing congestion and rendering the circulation more normal. Properly it is not painful, and leaves the patient with a sense of added comfort. It should be repeated at two- or three-day intervals. It is particularly serviceable in the treatment of prostatism associated with small prostates.

X-Ray and Radium.—Some cases of prostatic enlargement have been cured by radium applied through the rectum, through the urethra, or through a suprapubic opening. Neither the dosage nor the form of enlargement most amenable to the treatment has been fully determined. The X-ray promises less than does radium.

Catheterism.—The catheter is used for the relief of retention. It may be required occasionally, as in cases of acute retention, habitually, as in cases of chronic retention with or without distention, or continuously, as in cases of infection with systemic absorption. In using a catheter for the relief of retention that instrument should be selected which enters the bladder most easily, usually an elbowed soft rubber catheter. Each introduction should be preceded by urethral irrigation, preferably with protargol solution 1 to 2000, since the anterior urethra is always infected. (For details of Catheterism, see p. 70.) All forms of urinary retention caused by enlarged prostate are amenable to treatment by regular cleanly catheterization, and in those cases characterized by acute complete retention this treatment may be curative, at least to such an extent that the patient is again able to void his urine and is troubled only by frequency, some loss of power in the stream, and a residuum too insignificant to produce troublesome symptoms. In all other forms of progressive retention, either with or without infection, the catheter may serve a useful purpose in saving the bladder and kidneys from the inevitable effects of unrelieved and steadily increasing back pressure.

It should be used for the relief of retention as often as is needful to prevent the bladder from containing more than eight ounces at a time, and should be supplemented by mild antiseptic urethral and vesical irrigations. Vesical irritability associated with inability to pass any water at all, or at most a few drops, may require the use of the catheter much more frequently, this being particularly the case when there is complete retention in a non-distended infected bladder.

When, because of back pressure or infection, or a combination of these conditions, renal insufficiency develops, characterized by gastro-intestinal breakdown, hebetude or somnolence, and other uræmic manifestations, or by septic fever, continuous catheterization is peculiarly serviceable. A catheter continuously worn in the urethra causes a urethritis which in the course of months practically destroys the mucosa. By withdrawing the instrument twice daily while a cleansing irrigating fluid flows through it, and by changing the instrument before it becomes roughened by urinary deposits, such an instrument may be worn for years, the patient keeping it corked until such time as he cares to urinate.

The mouth administration of urinary antiseptics, particularly hexamethylenamine and salol, is specially indicated before an instrument is passed into a non-infected bladder and for two or three days thereafter; the long-continued administration of these drugs is undesirable. Though catheterization usually implies infection, this is not always the case. Some individuals seem immune even when filthy instruments are carelessly used with great frequency.

The complications incident to catheterization are: difficulty in the introduction, either mechanical or incident to pain, in the latter case greatly relieved by preliminary instillations of four per cent. eucaine solution; urethritis, prevented by irrigation each time the instrument is passed; epididymitis, prevented, if recurring, by vasectomy; hemorrhage, avoided by the selection of the proper instrument and extreme gentleness; and infection at time prevented by antiseptic irrigations and cleanliness.

Operative Treatment

As a rule, when habitual use of the catheter is required, the patient's best interests will be consulted by advising operation, the expectation of life being greater with operation than with catheterism, while the physical comfort after operative treatment, as compared with the continual annoyance of catheterism, is vastly to be preferred. This may take the form of—

1. Over-dilatation of the internal vesical sphincter, applicable to cases of small hard prostates, complicated by sclerosis of the sphincter.

2. Prostatotomy, or incision of the internal vesical sphincter and prostate, particularly applicable in the small sclerosed prostate.

3. Prostatectomy, or enucleation of the prostate gland or the adenomata which cause the obstruction, applicable to all cases of prostatic enlargement causing sufficient obstruction to engender harassing symptoms and threaten renal integrity.

4. Castration or vasectomy.

5. Cystostomy, applicable to cases of inveterate cystitis, in which the systemic condition is such as to make unjustifiable the more radical procedure.

Preoperative Examination and Preparation.—The first examination deals with the exclusion of tabes, by testing the patient's station, pupil reflex, and knee jerks, the estimation of cardiovascular competence by observing the effect of exercise upon the heart action, the respiration, and the peripheral circulation, and consideration of the question of renal adequacy as suggested by the mental vigor, interest in life, appetite, and maintenance of normal weight and endurance.

The question of renal competence being perhaps the major one in deciding for or against radical operation is further decided by the quantity of urine passed in twenty-four hours, its specific gravity, and the presence or absence of abnormal content, but particularly by the various tests of elimination, especially that employing phenolsulphonephthalein (see p. 21). The presence or absence of sugar is of itself of little moment.

Given a slow and low phthalein output, associated with weakness, lethargy, loss of weight, and loss of appetite, the dominant question is as to whether the kidneys have been irretrievably damaged by long-continued back pressure, or are capable of regaining all or a part of their lost power should the back pressure be removed. The question is best settled by instituting continuous catheterization, or, should this prove harassingly painful, by suprapubic drainage effected under local anæsthesia.

The first effect of removing the back pressure on the kidneys produced by any considerable quantity of residual urine is fourfold: a reduction in the blood-pressure, urinary output, and functional power, as indicated by their ability to eliminate such test substances as phenolsulphonephthalein, and an increase in the quantity of albumin, or an appearance of this element, all incident to renal congestion. To these must be added, in case the bladder has previously been free from infection, in the great majority of cases the development of an acute cystitis. The tax of these factors on the vital reserve of a patient already past the prime of life is heavy, often all that he will bear. It would therefore seem the wiser course not to add at this time the shock of general anæsthesia and prostatectomy, but to delay this operation till the system has had an opportunity to effect a readjustment. This may take place in the course of a few days, or not till after the lapse of many weeks or months; in some cases it may never take place to an extent to warrant the performance of a radical operation, in which event the patient should content himself with permanent suprapubic drainage or catheterism.

Stretching of the Internal Vesical Sphincter.—This is indicated in those cases of prostatism without prostatic enlargement. The obstruction to the urinary flow is here due to a sclerosed condition of the internal vesical sphincter, a muscle which in its normal state relaxes when the bladder contains three or four ounces of urine. This sphincter should admit the index-finger, but when, as a consequence of chronic prostatitis or inflammation about the vesical neck, it undergoes probably first hypertrophy and afterward fibroid degeneration, it forms a narrow hard ring into which the tip of the little finger can be passed only with difficulty, though it may admit a 28 sound passed through the urethra with only a slight sense of resistance.

This operation may be accomplished under nitrous oxide by means of a dilating instrument which we have had constructed, especially for this purpose, the extreme calibre of which is seventy-five millimetres. Stretching to forty-five. the extreme calibre of the usual prostatic dilator, is inadequate.

In employing this treatment the urethra and bladder are first flushed with 1 to 2000 protargol solution. The distance from the meatus to the internal vesical sphincter is carefully measured and the instrument is introduced so that its dilating part lies exactly within the grip of this muscle. Its position

can be further assured by the finger of an assistant in the rectum. The patient is then given nitrous oxide and the screw in the handle is rapidly turned until the dilating part reaches its full calibre. Excepting for the use of a bland diet and urinary antiseptics by the mouth, there is no after-treatment.

Prostatotomy.—By this term is meant incision through the internal vesical sphincter and into the substance of the prostate. It may be made either with the knife, with the prostatic punch (Young's), or with the galvano-cautery instrument, through a perineal incision or through the urethra (Bottini's operation). Each has for its end the removal of obstruction, by direct division in the first two instances, and by division supplemented by extensive sloughing in the last. All are especially applicable to small hard prostates complicated by retention and probably by sclerosis and contracture of the internal vesical sphincter, though the advocates of the Bottini operation claim for its proper application usefulness in nearly all forms and degrees of prostatic enlargement.

Perineal prostatotomy performed by the knife is useful in providing an efficient route for permanent drainage of the bladder, this procedure being especially indicated in those conditions of cystitis so pronounced that permanent catheterization is either unbearable or inefficient, and associated with a contracted, rigid, and inflamed bladder too small to be readily drained by the formation of a suprapubic fistula.

Perineal prostatotomy can be performed under local anæsthesia; it is, however, better to employ nitrous oxide, since not more than one or two minutes are required for the completion of the operation.

After preliminary antiseptic irrigation of the bladder, a grooved staff is passed, and upon this, by an inch long incision passing through the perineal centre, the membranous urethra is opened. A probe-pointed knife engaging in the groove of the staff, the blade is passed into the bladder and then withdrawn, cutting forward and backward through the internal sphincter and into the substance of the prostatic commissure. The finger should then be passed along the staff and the latter withdrawn. Thereupon the interior of the bladder may be palpated. The vesical neck should be further dilated to at least 74 F. This may be accomplished by Spencer Wells forceps or a uterine dilator. A drainage-tube fully the size of the little finger and rigid should be so secured that its inner opening is just within the bladder, and to this tube should be connected a urinal placed at a level sufficiently low to drain the bladder. When it is intended to establish a permanent fistula, Watson's tube of hard rubber and designed especially for this operation will be found efficient. When the drainage is meant to be temporary, a large size soft rubber catheter (30 F.) will be found serviceable. Exceptionally, hemorrhage is so severe as to require packing. The bladder is irrigated at least twice daily with silver solution. The patient need not be kept in bed for more than a day unless this be indicated by his general condition.

A perineal fistula is less desirable than one placed suprapubicly, and should be formed as a permanent palliative measure only when the latter is impracticable.

"Prostatic Punch" Operation.—This is performed by means of a special instrument, such as that designed by Young, consisting of a tube (see B, Fig. 216) with a deep notch near its angle for the reception of the prostatic bar,

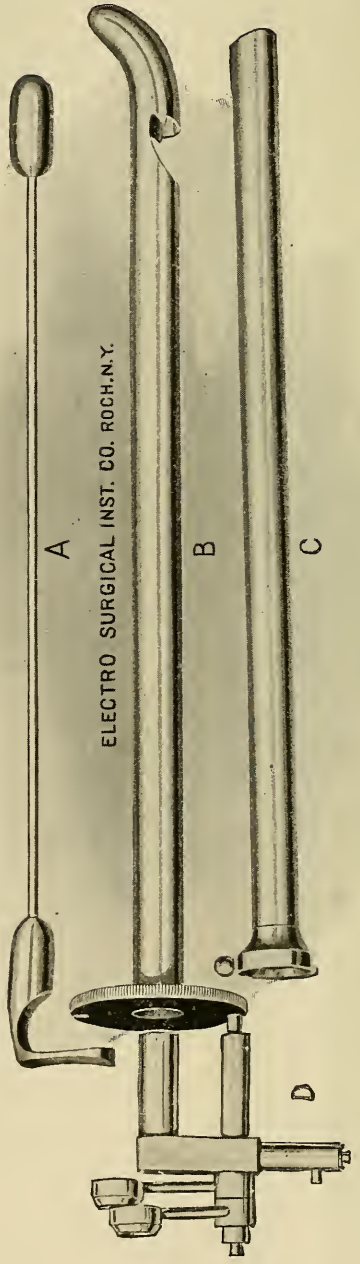


FIG. 216.—Young's prostatic punch. A, obturator; B, urethroscopic tube; C, punch; D, lamp.

into which the knife-edged tube *C* can be slipped for the purpose of removing whatever is engaged in the notch. Three pieces are usually removed, the first in the median line, the second and third at the sides of the first. The operation may be performed under local or nitrous oxide anæsthesia. The hemorrhage following the operation may be sufficient to require the use of a large aspirating tube for the evacuation of the clots.

Galvanocautery Prostatotomy through a Perineal Opening.—Chetwood has suggested galvanocautery incision through a perineal opening. His instrument (Fig. 217) resembles that devised by Bottini, but the blade is drawn out by a direct pull to a stop-pin which is set at the desired point. The results are verified by digital exploration. Moreover, complications may be more readily treated and the danger of urinary extravasation from an incision carried into the membranous urethra is entirely obviated. The thorough exploration allowed by the perineal opening enables the surgeon to proceed at once to a complete prostatectomy in case this be deemed advisable.

Bouffleur has modified the galvanocautery operation by performing it through a suprapubic cystotomy incision, using the actual cautery heated to white heat. Many cases can be treated efficiently through the cystoscope by means of the Oudin current (see p. 56).

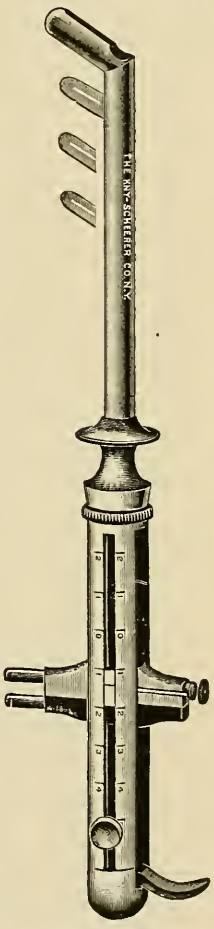


FIG. 217.—Chetwood's galvanocautery prostatic incisor.

PROSTATECTOMY.—Removal of the gland is indicated in all cases of pronounced enlargement with symptoms of progressively increasing urethral obstruction, when the general condition of the patient warrants the performance of the operation. The softer and larger the gland the easier and safer, as a rule, is the operation. Small dense fibroid prostates, particularly those which are the seat of chronic inflammation, are least amenable to this treatment, the difficulties of removal being great and the operative sequelæ being frequently unsatisfactory.

The gland may be removed through a suprapubic opening, the operation being conducted mainly by the guidance of touch, or through a transverse curved perineal opening, the operation being directed by both the senses of touch and sight.

As to the choice of operation, it is apparent that by either route the great majority of prostates can be removed. The small sclerosed prostate, the capsule of which is densely adherent to the fibrous sheath, can be most safely reached and enucleated through a transverse perineal opening. Soft fibro-glandular prostates can be readily and safely enucleated by either method.

In general terms, when the enlargement is mainly of the median lobe, when there is a complicating stone, or when it is desirable to make a direct inspection of the bladder for any reason, the suprapubic operation is to be preferred; when

the prostate is relatively small, hard, and fibrous, likely to be adherent on account of an old inflammatory condition, and in the very fat, the perineal is the operation of choice; the removal of adenomatous enlargements of the lateral lobes can be accomplished easily by either route. In selecting the type of operation the experience of the individual operator should receive about equal consideration with the character of the prostate. For the surgeon without special knowledge of either route, the suprapubic is the easier and probably the safer.

As in all conditions implying impaired renal competence, nitrous oxide is the anæsthetic of choice; thereafter in order to safely follow spinal anæsthesia, ether, and chloroform.

Suprapubic Prostatectomy.—For the performance of the transvesical operation the patient is placed upon a table so constructed that in case of need the Trendelenburg position can be easily obtained, his bladder irrigated and filled with eight to twelve ounces of protargol solution (1 to 2000), and a median incision made from the pubis upward for two to four inches, according to the size of the prostate and the thickness of the patient's abdominal wall. Packing the peritoneum upward and backward with gauze, and retracting the recti muscles, a clean high cut is made through the prevesical fat to the bladder-wall, clamping and tying veins if they be in the way. An incision is then made into the bladder at a point as near the vertex of the organ as possible without wounding the peritoneum, as the healing is more prompt, and the danger of a persistent sinus is more remote when a high incision is used. The opening in the bladder-wall is then drawn into the parietal wound by means of heavy silk threads passed with a curved needle through the whole thickness of the bladder on each side of the vertical cut.

The margins of the bladder wound are then held apart and a digital examination made to determine the presence or absence of stones or neoplasms and the conformation of the prostate.

The enucleation of the prostate, or of such part thereof as is removed, can usually be accomplished with one or two fingers without the aid of instruments, though sometimes it is necessary to use a long pair of scissors or a knife to make an opening in the mucosa, or to free a dense adhesion. The finger-nail tears through the mucosa in the anterior wall of the prostatic urethra where it opens into the bladder, as when started here it is easier to get into the proper line of cleavage than when the intravesical portion of the gland is first attacked (Fig. 218). This line of cleavage lies within the capsule of the gland, in adenomatous prostates between the hypertrophied tissue and the compressed but otherwise unaltered parenchyma or the capsule. When extracapsular removal is attempted, not only is the enucleation difficult, but profuse hemorrhage is encountered from the prostatic venous plexus. Counter-pressure by one or two fingers in the rectum is always helpful, usually necessary, for complete, safe, and expeditious removal. Traction upon the partly enucleated gland by means of forceps is often helpful in the latter part of the dissection.

The removal of small fibrous prostates by the suprapubic route is often attended by extreme difficulty, and must often be accomplished piecemeal.

At the conclusion of the operation through the urethra the bladder is freed

of blood and clots by irrigating with hot solution, and if there be no excessive bleeding the bladder incision is closed tightly about a large drainage-tube, the size of the index-finger, whose fenestrated end projects one or one and a half inches into the viscus. Should there be free bleeding, the patient should be placed in the Trendelenburg position, retractors inserted, the interior of the bladder dried, and gauze packing wet with adrenalin solution placed in the prostatic bed, the end being brought out through the incision. Should this fail to control the hemorrhage, the packing may be grasped with forceps, the handles of which project through the suprapubic incision, and pressed upon by an

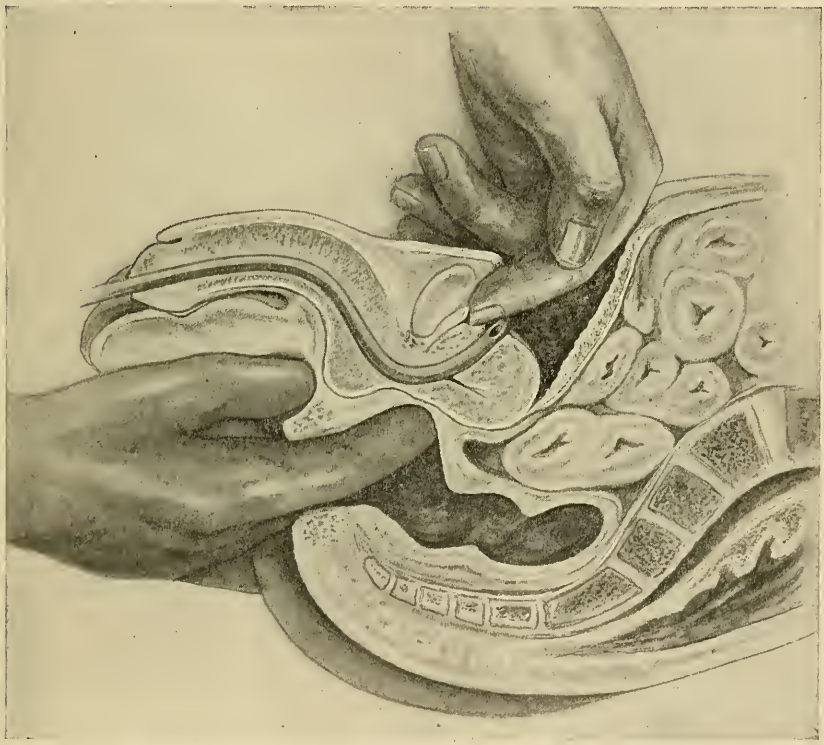


FIG. 218.—Suprapubic prostatectomy, beginning the enucleation.

Esmarch's bandage passed about the body. In addition to the bladder drainage, a cigarette drain should always be placed in the space between the bladder and the pubis, as this region is peculiarly liable to infection.

Postoperative Treatment.—After operation the patient is given half normal saline solution by the bowel, a pint every three hours, unless it becomes prohibitively irksome. The suprapubic drainage is led by rubber tubing of full size into a reservoir placed at a lower level than the bladder, and twice daily by means of a short urethral nozzle and a gravity bag the bladder is flushed out with protargol (1 to 4000). The large tube protects in a measure from blocking by clots; should this occur as shown by vesical distention, pain and

an urgent, continued, and distressing desire to urinate, the tube should be freed by aspiration and irrigation. The patient may be allowed to sit up as soon as he feels so inclined, and may usually be gotten into a chair on the third, fourth, or fifth day. The cigarette drain should come out on the second day, and on the fifth to the seventh day the bladder tube may be removed, or replaced by a tube or catheter of smaller size.

Operative Results.—After suprapubic prostatectomy a certain amount of prostatic tissue usually remains, the dissection having been made between the adenomatous overgrowth and the compressed prostatic tissue. Usually the greater part of the prostatic urethra comes away with the growth, but, as the canal is usually broken across at the verumontanum or a little behind this point, the patient is not necessarily rendered sterile. Nor in those virile previous to operation is impotence a necessary sequel.

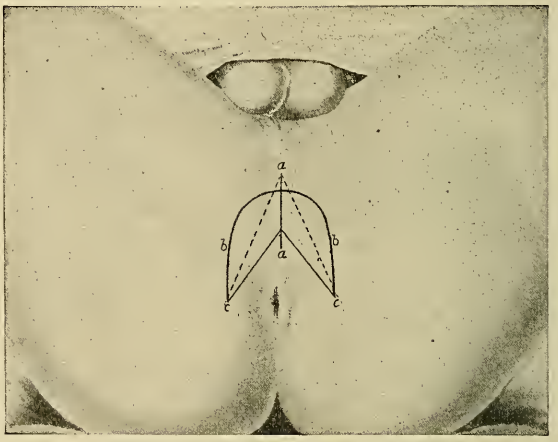


FIG. 219.—Various perineal incisions.

The suprapubic opening closes in from ten to twenty days, and the patient regains the power of prompt, forceful, continuous micturition, with almost normal intervals between the acts. Many patients continue to exhibit indefinitely slightly cloudy urine, moderate frequency with one or two night risings, and a small residuum, two to four ounces. They nearly all show an amazing betterment in general health, as though youth were regained.

Perineal Prostatectomy.—The prostate has been approached from the perineum by two routes: through median incisions and through semilunar or inverted " V " incisions.

Median Perineal Route.—By this method an incision is made in the membranous urethra through which the finger is introduced into the prostatic portion. Such portions of the prostate, usually adenomatous masses, as can be enucleated are freed with the finger and withdrawn with forceps, and the operation is concluded by putting a gauze drain in the prostatic bed.

The operation is performed entirely by the sense of touch, in an inadequate space, is accompanied by great trauma to the urethra, and is applicable only to easily enucleable enlargements of moderate size.

Transverse Perineal Route.—This is the method usually followed in doing the perineal operation. It is the one used in his conservative perineal prostatectomy by Young, the foremost advocate of the perineal route. The method of performing this operation is as follows:

A grooved staff—Ferguson's is the best—is introduced into the urethra, and the patient is placed in the exaggerated lithotomy position, the pelvis being raised from the table either by means of Halsted's perineal board or a sand-bag, the thighs being flexed on the abdomen, so that the perineum is nearly parallel with the floor. The skin and superficial fascia are incised, either by a semilunar cut or by an inverted " V " incision (see Fig. 219), the anterior portion of the exposed area lying over the bulb, while the posterior extremities of the incision are on a level with the anterior margin of the anus.

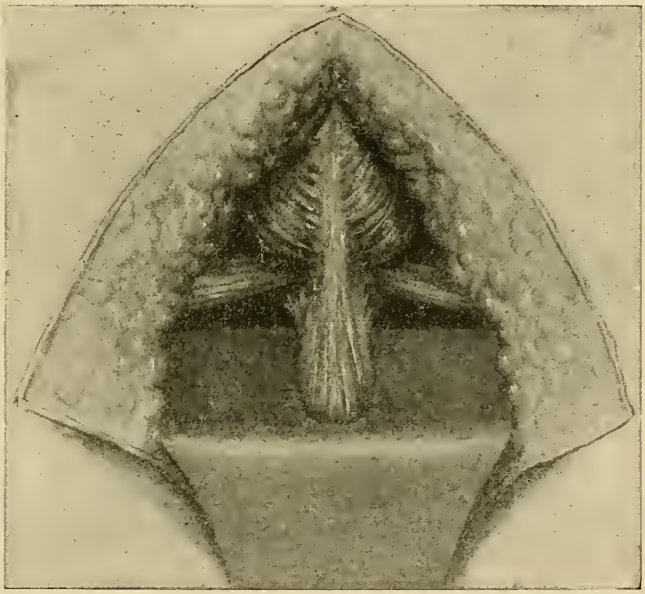


FIG. 220.—Showing bifid retractor, exposing and making tension on the central tendon. (Keen's Surgery, Courtesy W. B. Saunders Co.)

By blunt dissection a space is now opened on each side of the central tendon of the perineum, the transversus perinei being pushed forward. A bifid retractor is inserted (Fig. 220), and, close to the bulb, the central tendon and the recto-urethralis muscle are divided, great care being exercised not to cut into the rectum, which is drawn forward by the latter structure. The levator ani muscles thus exposed are separated in the median line and a broad retractor inserted, bringing the posterior surface of the prostate into view. The next step is to incise the membranous urethra on the staff, and to insert the prostatic tractor into the bladder. The insertion of this instrument (see Figs. 221, 222, and 223) is greatly facilitated if the urethral walls, including the mucosa, are caught with sutures or forceps as soon as the incision is made. On account of its abrupt curve the tractor is not always easy of introduction; sometimes

this is most easily accomplished by starting with the handle pointing toward the floor, and later rotating it through an arc of 180 degrees. After insertion

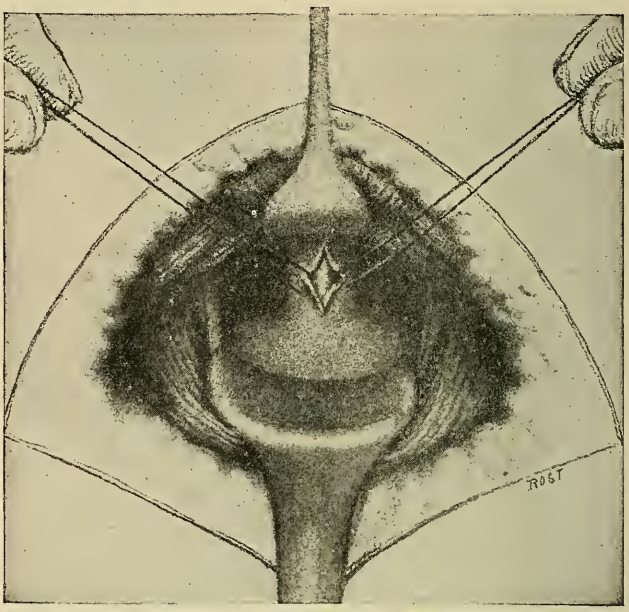


FIG. 221.—Opening of urethra on sound, preparatory to introduction of tractor. (Young.)

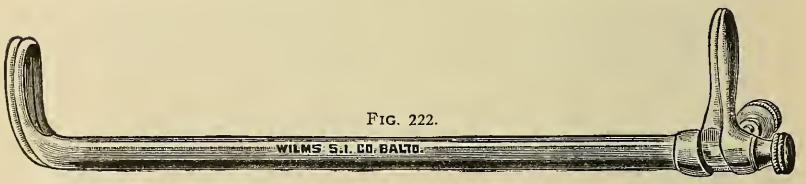


FIG. 222.

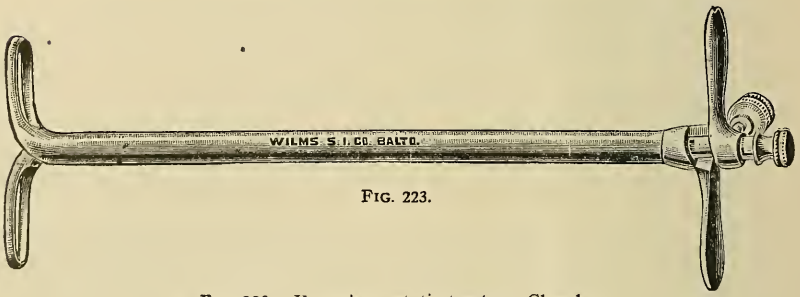


FIG. 223.

FIG. 222.—Young's prostatic tractor. Closed.
FIG. 223.—Young's prostatic tractor. Opened.

the blades are opened so that accidental withdrawal is impossible; by traction upon it the prostate can be drawn downward into the wound very substantially.

The whole posterior surface of the prostate is now exposed bluntly after incision of the posterior layer of Dénonvilliers' fascia, the exposure being made more complete by the insertion of narrow lateral retractors.

To give access to the lateral lobes, two incisions, 1.5 cm. deep, are made in the posterior surface of the organ for nearly its whole length, the incisions

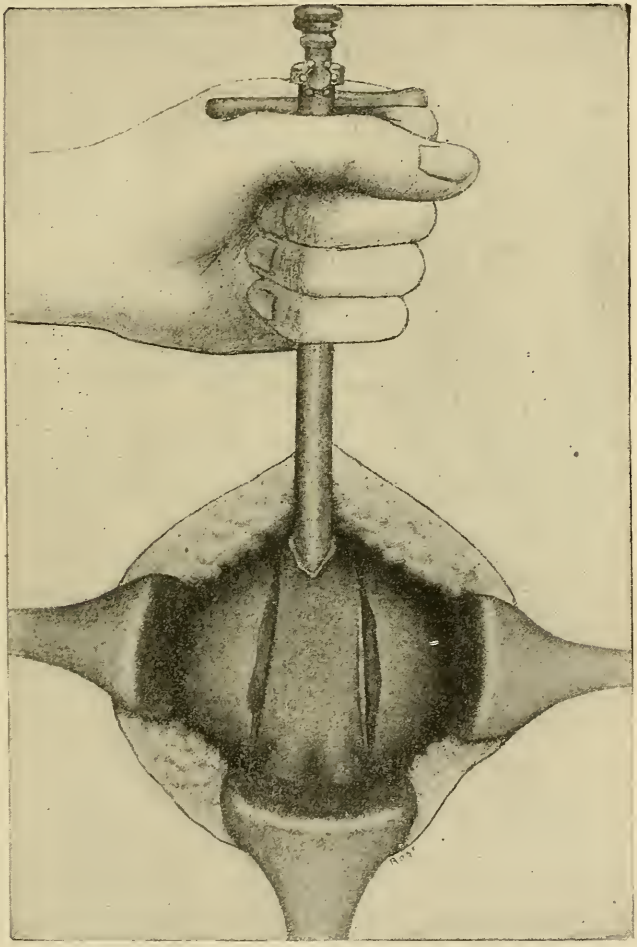


FIG. 224.—Tractor in position, blades separated, prostate pulled down, posterior surface exposed. Incisions in capsule on each side of ejaculatory ducts. (Young.)

being about 1.8 cm. apart above and 1.5 cm. below (Fig. 224). The tissue between these incisions contains the prostatic urethra and the ejaculatory ducts, and is therefore not to be removed. The enucleation of the lateral lobes is started by inserting a blunt dissector beneath the capsule to the outer side of one of the incisions (Fig. 225), and continued with dissector, curved scissors, or finger, as is found most convenient, the tractor being used to steady the prostate by making counter-pressure on its vesical surface. Firm adhesions to the cap-

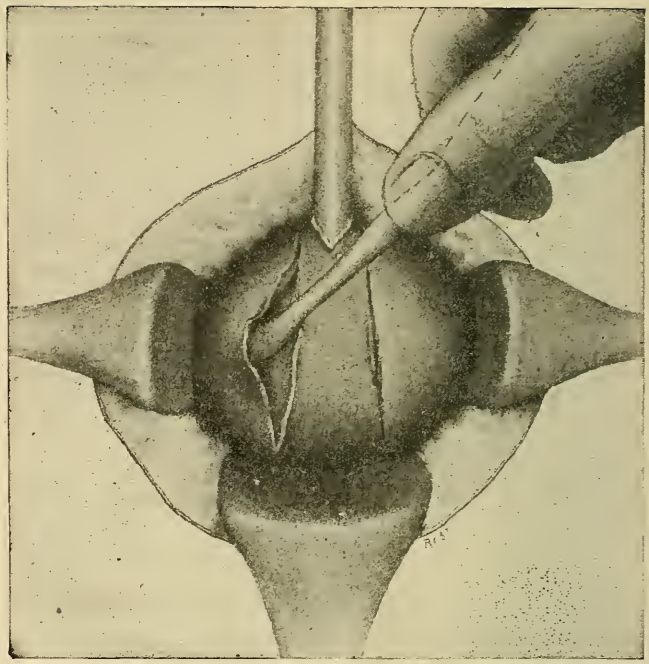


FIG. 225.—External enucleation begun. (Young.)

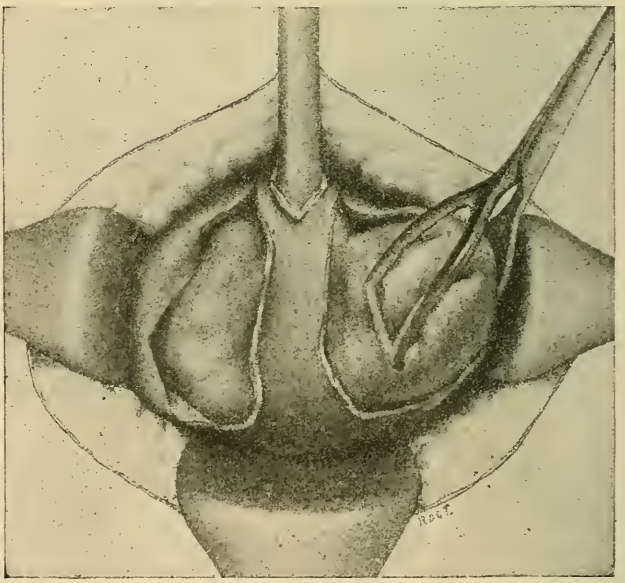


FIG. 226.—Enucleation of lobes. Forceps in position. (Young.)

sule, requiring division with scissors, are usually found at the apex. After the lobes have been partially freed the application of forceps is of great assistance (Fig. 226).

After the lateral lobes have been removed, if a median lobe exists this is engaged by one of the blades of the tractor and pushed to one side or the other (Figs. 227 and 228). Median bars are best delivered by transfixing them with a sharp hook, passed in through one of the lateral cavities. In the case of either median lobes or bars the dissections must be made from the ejaculatory ducts lying behind and from the vesical mucosa in front. The operation is concluded with a careful digital exploration by means of the finger and tractor to see that no enlargement has been overlooked. This exploration should include the insertion of the finger into the bladder through the urethra, the tractor having been removed after securing the urethral walls that the

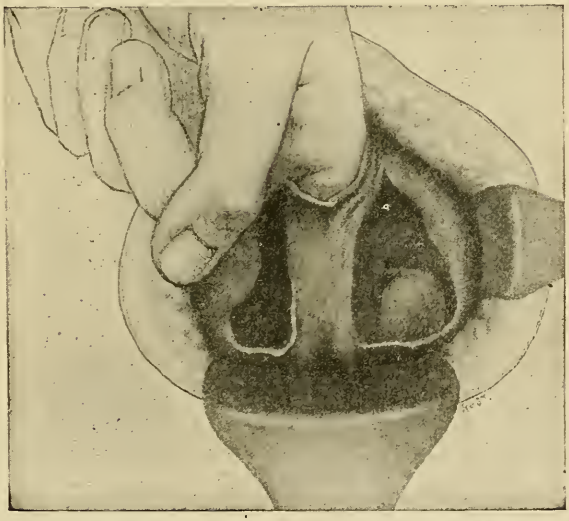


FIG. 227.—Delivery of a small median portion into lateral cavity by the use of finger instead of tractor. (Young.)

proper channel may be easily found. This examination determines, first, the condition of the vesical neck, whether or not there is any contracture, and, secondly, whether stones exist in the bladder, if this fact has not been already ascertained by means of the cystoscope. Should there still be contracture of the neck, this must be thoroughly stretched by means of heavy forceps. Calculi may be removed either through the urethra, if this is sufficiently large, or by incising one of its walls if more room is required (Fig. 229).

The lateral cavities should be packed with gauze and the bladder drained by means of a large tube (double if continuous irrigation is to be used) (Fig. 230). brought out through the anterior portion of the wound. Behind the gauze and tube drains, so as to protect the rectum from pressure, the levator ani muscles are approximated with a single catgut suture. The skin wound is closed with interrupted or continuous sutures of silkworm gut or silk.

Postoperative Treatment.—The drainage-tube is connected with a reservoir

placed at a lower level than the bladder; through the tube the bladder is washed twice a day with protargol (1 to 4000). Blocking of the tube by clots is relieved by aspiration, or by removal and replacement of the tube.

At the end of twenty-four hours the gauze packing is removed, and a few hours later the tube is withdrawn from the bladder. The patient should now

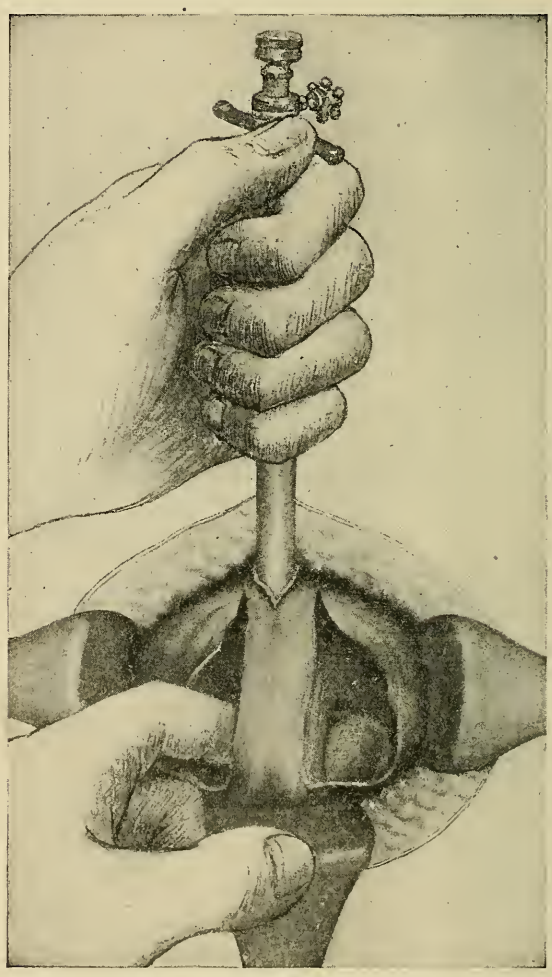


FIG. 228.—Delivery of median portion into lateral cavity. (Young.)

be urged to sit up in bed for a brief period; he should be gotten into a chair on the second to the fourth day, and may walk about as soon as he feels so inclined.

Partial reëstablishment of the normal urinary channel often takes place as soon as the drainage-tube is removed; the average time for the closure of the fistula is two to three weeks.

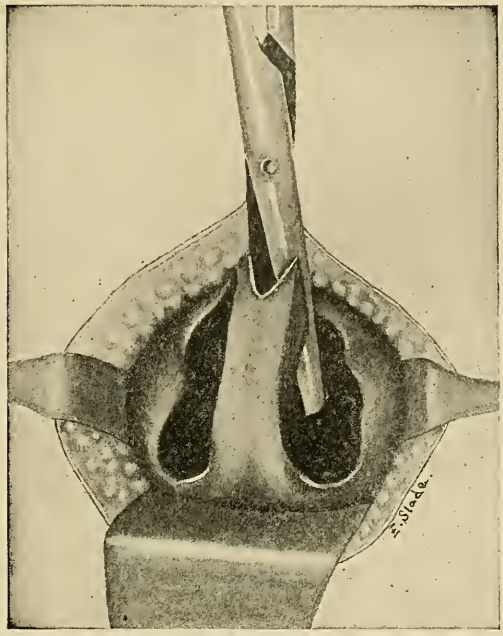


FIG. 229.—Division of lateral wall of urethra to allow extraction of large calculus through lateral cavity. (Young.)

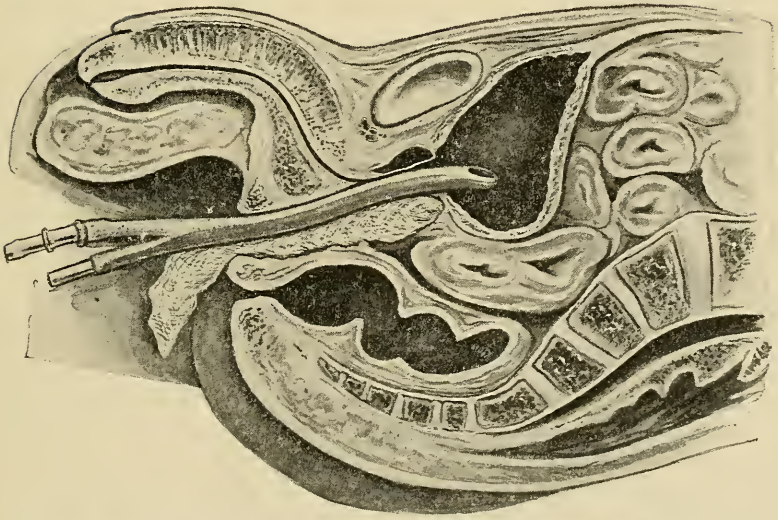


FIG. 230.—Manner of introduction of double tube drain into bladder and packing into bed of enucleated prostate in perineal prostatectomy.

The Results of Prostatectomy.—The removal of the prostate, if skilfully conducted in properly selected cases, usually affords a permanent cure of urinary retention, and, moreover, produces a peculiarly regenerating effect upon the patients so treated.

The mortality incident to prostatectomy varies with the care used in the selection and preparation of cases, with the skill of the operator, with the type of operation, and with the care used in the after-treatment. The need for care in the preliminary examination and pre-operative treatment of these patients has already been dwelt upon. That for the best performance of an operation of the severity of prostatectomy the judgment and skill of an experienced operator are of advantage needs no argument. The perineal operation seems to have a slightly lower mortality than the suprapubic, so far as can be judged from published statistics, possibly because of better drainage of the bladder, more probable because it is the custom to get these patients out of bed at an earlier date. On the other hand, injury to the rectum, incontinence of urine, impotence, and urinary fistula are more apt to follow the perineal than the transvesical procedure.

The postoperative care is a factor of great import. Water by mouth and rectum, adequate vesical drainage (*i.e.*, tubes which constantly work), relief from wearing pain by morphine, mild antiseptic irrigation twice a day, deep breathing and light surface massage, changes of posture, the avoidance of food till the patient is ready for it, easy emptying of the bowel on the third day, medicinal treatment directed to cardiovascular and renal inadequacy, and the conservative use of urinary antiseptics (salol, hexamethylenamine) are all measures bearing on the postoperative result.

The mortality of operators with special skill in the performance of the operation lies between three and five per cent.; when great care is taken in the pre-operative examination and treatment of patients the mortality of operators of average skill usually lies between five and ten per cent.; while when these precautions are not taken the same men would usually have a mortality of from ten to twenty per cent.

Epididymitis after Prostatectomy.—This complication follows the perineal and suprapubic operations with about equal frequency. Usually it comes on within a few days of the operation, but occasionally not till weeks afterward, when the patient has gone home. The infection is accompanied by fever and marked toxæmia, and in not a few cases has had a fatal termination.

Epididymotomy is the treatment of choice, on account of the danger of a lethal termination, and the promptness of the relief obtained by this procedure. Nitrous oxide should be administered, and a knife plunged into the region of greatest induration. The relief seems to be equally prompt whether or not pus is found. If an abscess is located a gauze or tube drain should be inserted, otherwise the scrotum should merely be elevated, and a compress wet with a saturated solution of magnesium sulphate be applied.

Castration and Vasectomy.—The removal of the testicles or sections of the vasa has been performed many times for the purpose of causing reduction in the size of enlarged prostates, following the suggestion of one of us (White), based on the observation that the prostates of dogs atrophied following orchi-

dectomy. The procedure is at times curative, though not invariably so, and on account of the recent advances in the technic of prostatectomy it has of late fallen into disuse; however, it is still to be considered when prostatectomy is deemed inadvisable, either because of the condition of the patient or of the inexperience of the operator. Vasectomy is a less efficient procedure than orchidectomy.

ATROPHY OF THE PROSTATE

In exhausting diseases accompanied by general wasting of the entire body marked atrophy of the prostate may occur. Thus, Thompson noted one case in which the gland weighed less than one drachm. Extreme old age is usually accompanied by wasting of the prostate; mechanical pressure, as from extravesical tumor or prolonged distention of the bladder, may produce the same effect. The gland may also be partly or completely destroyed by abscess-formation followed by cicatricial contraction and by sclerosis secondary to chronic inflammation. In certain cases the prostate is congenitally atrophic, this condition being generally associated with other malformations. Castration, especially if performed in early life, is always followed by prostatic atrophy; masturbation, if begun early, and if excessive and long continued, may result in a similar condition. Symptoms of atrophy are practically wanting.

The diagnosis is founded upon rectal examination.

Treatment is unavailing.

PROSTATIC CALCULI

Thompson has shown that the corpora amylacea are so constantly found in the prostate that their presence can scarcely be considered abnormal. In youth these bodies are usually microscopic in size. Later in life they become larger, so that they are readily seen by the naked eye. The name corpora amylacea is given to them because they exhibit a granular nucleus, probably made up of degenerated epithelial cells and inspissated mucus, about which are formed concentric layers composed of an albuminoid substance, and presenting the microscopic appearance of starch cells.

When the corpora amylacea are small they occasion no symptoms: as they grow larger they act as foreign bodies, exciting inflammation, and have deposited in and upon them the salts of lime, calculi being thus formed. The calculi may lie separately, each in its own pouch, or many of them may be placed in a common pouch, when often adherent to one another. In color they are brown or black, with a smooth polished surface, exhibiting facets when a number of calculi are placed together in a single pocket. They are made up of calcium phosphate, calcium carbonate, and organic matter, and are commonly found below the urethra, particularly in the region of the verumontanum. If by ulceration the cavity in which they lie opens into the urethra, and the urine has access to them, its salts will be deposited upon them, causing rapid growth, abscess-formation, and ulceration, usually in the direction of the urethra, but sometimes towards the bladder, or into the rectum or the perineum.

Prostatic calculi may originate in the substance of the gland as just described, may come from the bladder or the urethra, or may be deposited from

the urine in suppurating prostatic pouches. After removal of the prostate there may be left an ulcerating cavity which gradually becomes filled with a hard, calcareous mass, causing obstructive symptoms, and yielding to the examining finger the wooden induration characteristic of cancer.

Symptoms.—Until prostatic calculi of glandular formation open into the urethra, symptoms are usually wanting, the condition not being generally recognized until it is shown by postmortem examination or operation performed for some other pathological condition. When the calculi begin to grow from deposition of urinary salts, the symptoms of posterior urethritis or of chronic prostatitis develop.

Diagnosis is founded on rectal palpation and urethral examination. These calculi, if of considerable size, can generally be felt by the finger introduced into the rectum. A metal catheter will give a grating sound as it is introduced into the prostatic urethra; urethroscopic examination will bring the concretions directly into view. The X-ray gives a characteristic shadow.

Treatment.—It is sometimes possible to remove calculi from a suppurating prostate by the straight or slightly curved urethral forceps. A perineal urethrotomy affords the safest and best route for thorough removal of these concretions. The median perineal incision gives enough room; exceptionally, when it is necessary to make a careful exploration of the entire prostate, the semilunar incision in front of the anus is required, the anus with its sphincter and the rectum being carried backward, the prostate exposed, and the calculi freed and removed through the incision. For the very small calculi which pass spontaneously no treatment is necessary other than avoidance of all causes of prostatic congestion, as constipation and alcoholic or sexual excess. When in consequence of prostatic calculi there are harassing pains, undue frequency of urination, retention of urine, or cystitis, surgical intervention is imperatively indicated.

TUMORS OF THE PROSTATE

Cysts of the Prostate

Cysts of the prostate are either hydatid or retention. The hydatid cysts are so extremely rare that symptomatology based on clinical experience can scarcely be formulated. The symptoms would naturally be dependent on interference with micturition or defecation, and pain.

The detection of a fluctuating, non-inflammatory tumor would lead to a diagnosis.

Retention cysts are frequently associated with hypertrophied prostates, but in any case are rare. Usually they are due to obstruction of the prostatic follicles. Exceptionally the cyst may be due to narrowing or obliteration of the opening of the utricle. In this case interference with micturition may readily occur. English found five examples of this affection out of seventy postmortem examinations of newly-born children.

The treatment is puncture through the perineum, evacuation, and drainage. In the case of infants suffering from retention of urine, rupture of the cyst may be effected by the passage of a small metal instrument.

MALIGNANT DISEASES OF THE PROSTATE

The prostate is subject to both carcinomatous and sarcomatous degeneration, the former being very much the more common.

CARCINOMA

Cancer of the prostate is a disease of men over forty: about fifty per cent. occurs in the seventh decade.

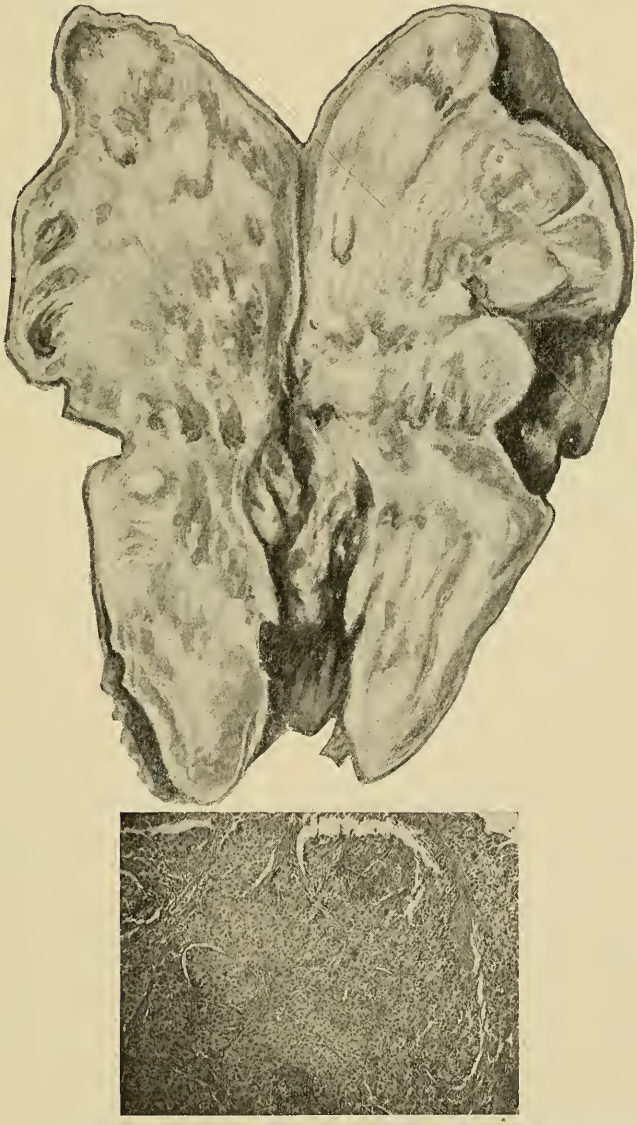


FIG. 231.—Carcinoma of the prostate; gross specimen and microscopic section. (No. 4409, Department of Surgical Pathology, University of Pennsylvania.)

From a clinical standpoint there are two types of carcinoma of the prostate, one in which the process long remains within the capsule of the organ, and one in which there is an early extension beyond the limits of the capsule, usually upward about the seminal vesicles. Extension into the bladder, into and about the urethra, and into the rectum, with ulceration of these structures, are all late and unusual occurrences. Metastases are also usually late developments; those in the lymphatics are found in both the inguinal and abdominal nodes. These secondary lesions may be much more extensive than the primary focus. Metastases to the bones, especially to the bodies of the lumbar vertebræ, are by no means rare, and may precede in their clinical manifestations the signs of prostatic involvement.

It is usual for all lobes of the prostate to be involved in the growth (Fig. 231); possibly the posterior lobe, lying between the ejaculatory ducts and the posterior capsule, is involved first by preference, but certainly it is not invariably the site of the onset of the trouble. It occasionally happens that small areas of carcinomatous degeneration are found in presumably benign prostates removed at operation (Fig. 232). Such cases may remain well for years, or be permanently cured.

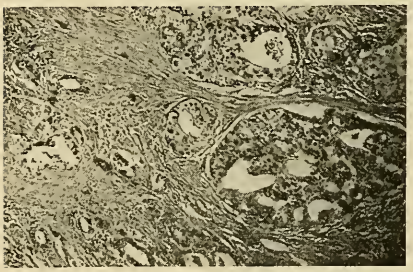


Fig. 232.—Carcinoma of the prostate. Arising from cellular hyperplasia of the acini.

Symptoms.—Carcinoma of the prostate in its early stages causes no symptoms which are indicative of the nature of the trouble.

The first symptoms are indistinguishable from those of prostatic hypertrophy of a benign type, difficulty and frequency of urination being the most common. The difficulty may be anything from a slight slowness in starting, with lack of force to the stream, to complete retention; and the frequency from a scarcely noticeable decrease from the normal interval to a condition of continual unrest, the patient attemping to empty his bladder every few minutes.

Pain is a later symptom, comes on at various stages in the course of the trouble, is present in various degrees and in a wide variety of locations, from the loins to the feet, though the usual sites are the bladder, the deep perineum, urethra, or penis, or all of these regions.

Hæmaturia is a late symptom, usually indicative of ulceration into the bladder or urethra; in the earlier stages it is rather less frequent than in benign hypertrophy.

The course of the disease may be rapid or slow, a matter of months or years. Usually a considerable period elapses between the onset of symptoms and the invasion of the periprostatic tissues, so that if the diagnosis can be made at the onset of symptoms—not always an easy matter—radical cure is an attainable result in a considerable proportion of cases. The microscopic examination of removed prostates shows, according to Albarran, changes indicative of beginning malignant degeneration in ten per cent. of cases.

Diagnosis.—The examination of the gland through the rectum must be depended upon for the diagnosis of early cases of carcinoma, or, if the findings

thus obtained are of doubtful import, microscopic examination of the removed gland must be resorted to. The carcinomatous prostate is harder than the normal gland, typically of a woodeny hardness which is quite characteristic. The surface of the organ may be either smooth or nodular, so the conformation cannot be relied upon in forming an opinion. In the more advanced cases the extension of the growth about and between the vesicles is easily detected and is quite characteristic, the only danger of confusion being with extensive seminal vesiculitis; the nature of a growth which is running riot through all the tissues of the pelvis, the "prostato-pelvic carcinosis" of Guyon, is, of course, unmistakable.

Prognosis.—When the diagnosis of carcinoma of the prostate is unmistakable there is little hope for cure. Death usually occurs from exhaustion, sepsis, or pyelonephritis incident to obstruction or ascending infection.

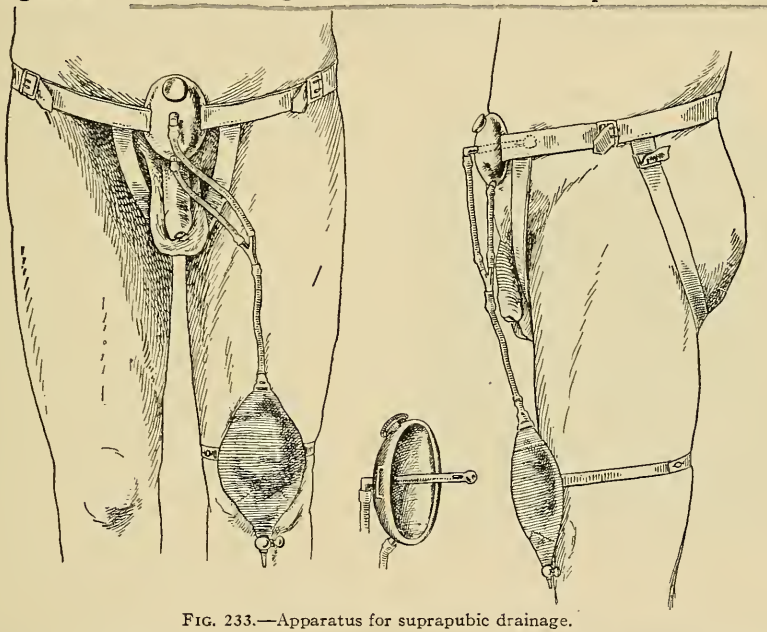


Fig. 233.—Apparatus for suprapubic drainage.

Treatment.—Hope of curing carcinoma of the prostate can only be entertained when the case is operated upon before the disease has extended beyond the limits of the prostate, by a method which includes all of the gland, its capsule, and the prostatic urethra in the tissue excised. The operation is best performed by the perineal route after the method of Young,[1] in which the membranous urethra is divided, the prostate freed and drawn down into the wound, and an incision made through the bladder-wall, beginning in front just above the gland, and continuing around to the base just below the ureteral orifices. The anterior portion of the bladder wound is then sutured to the urethra about a catheter, while the posterior portion of the wound is closed by transverse sutures. Incontinence of urine is to be expected after the operation.

[1] Young, in "Keen's Surgery," vol. iv, p. 465.

Palliative Procedures.—While a catheter can be passed without difficulty, regular catheterization is the treatment of choice for the distress caused by retention of urine. Later, when the urethra is obstructed by the encroachment of carcinomatous tissue, drainage of the bladder by means of a suprapubic cystostomy is the method of choice (Fig. 233).

SARCOMA

Sarcoma of the prostate, comparatively rare, occurs at any period of life, from infancy to old age; nearly fifty per cent. have been found in the first decade.

Sarcoma usually springs from the upper, posterior part of the prostate, and grows chiefly in an upward and backward direction. For this reason disturbance of urination is a relatively late symptom, and in most cases the tumor has reached enormous size when it is first discovered. In a few cases the urethra has been infiltrated, and sarcomatous projections have been found in its lumen; involvement of the mucosa of the bladder is rare. Practically all varieties of sarcoma have been found in the prostatic tumor (Fig. 234).

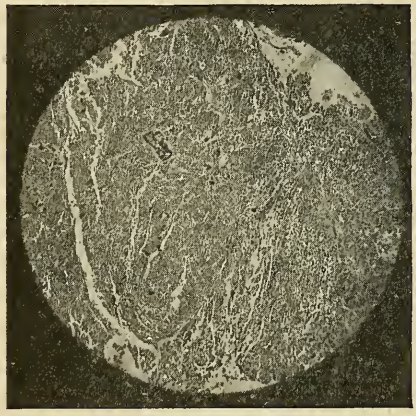


Fig. 234.—Photomicrograph of sarcoma of the prostate (small round cell).

The earliest symptoms of the disease may be those of urinary obstruction, or attention may be called to the growth by pain, or rarely by obstruction in the rectum. The course of the disease is more rapid than that of carcinoma, but in some cases symptoms have been present for over a year when the patients have applied for relief.

Diagnosis is again based on the rectal examination of the growth. While sarcomata differ much in their conformation and destiny, it is unusual to find one as hard as carcinoma, or even as a benign prostatic hypertrophy, and it is also unusual to find one which has not made its way beyond the sheath of the gland. Both smooth and nodular sarcomata are encountered. Some are so soft that there is danger of mistaking them for abscesses.

Treatment.—Few cases are suitable for the performance of operations, the object of which is the radical cure of the disease. In young subjects the best results seem to follow the drainage of the bladder by suprapubic cystostomy. In adults attempts to reëstablish normal urination by the removal of part of the growth are usually successful, and by this means patients have been rendered comfortable, so far as their urination was concerned, for as long as a year.

There is reason to hope that radium may be curative in at least some of these sarcomatous cases.

CHAPTER XIX

SEXUAL WEAKNESS AND STERILITY

The term impotence implies a lack of ability to perform the sexual act. It is not necessarily associated with sterility, nor is a sterile person necessarily impotent. Thus, patients whose ejaculations are premature and whose erections are feeble or wanting, though unable to have sexual relations, may discharge semen swarming with living spermatozoa; while those who are particularly vigorous in sexual congress may have no emissions, or may emit fluid entirely devoid of living spermatozoa.

Impotence in the male may be due to congenital or acquired deformity or to feebleness or deficiency in erection.

Mechanism of Erection and Ejaculation

In the ordinary condition of the penis the muscular fibres lining the trabeculæ are in a condition of tonic contraction; hence the spaces are obliterated. Moreover, the arteries are so contracted that no more blood is furnished than is sufficient for the nourishment of the parts; hence circulation is carried on as in other parts of the body. When the impulse is sent out from the erection centre the arteries dilate and the muscular structure of the erectile tissue relaxes; hence there are provided an increased blood-supply and spaces for its accumulation. At the same time, as a result of muscular contraction, the veins carrying the return blood are pressed upon and congestion is thus increased. As a result the erectile tissue becomes turgid, and this in itself adds to the tendency to engorgement, since the fibrous investment of the penis is put upon the stretch, and thus the venous return is materially interfered with. As the penis becomes tense and rigid it is mechanically carried upward to an elevation of about forty-five degrees by the action of the suspensory ligament, though both the erector penis and the accelerator urinæ, by drawing downward and backward upon the organ behind the position of this ligament, assist in maintaining this position. Erection is finally completed by the active participation of the perineal group of muscles. The erector penis, the accelerator urinæ, the transversus perinei, and the compressor urethræ by tonic contraction with clonic accentuations, materially increase the venous congestion.

With all the factors described in harmonious action, the penis becomes fully erect; its hardness is dependent upon the amount of engorgement and the density of its fibrous investment; the spongy body and the glans are never as hard as the cavernous bodies.

As the result of sexual excitement, coincident with erection, the testicles are drawn close to the abdomen by contraction of the dartos and of the muscular fibres of the cord. It is probable that the spermatozoa which fill the epididymis are rapidly carried by the peristaltic action of the muscular coat

of this tube and of the vas to the ampulla, from which dilatation, the ejaculatory duct being patulous, spermatozoa are driven into the prostatic urethra. In the meantime, as a result of the active congestion, the mucous glands and follicles of the urethra have been secreting a clear, slightly alkaline, viscid mucus, the possible purpose of which may be the neutralization of any acid urine which may remain in contact with this tube. At the time of orgasm the muscles of the prostate vigorously contract as the compressor urethræ muscle becomes relaxed: thus not only the spermatozoa and the contents of the seminal vesicles, but also the prostatic secretion, are driven forward into the bulbous urethra, being prevented from going back into the bladder by the congestion of the erectile tissue of the verumontanum and also probably by contraction of the internal sphincter of the bladder. Once in the bulbous urethra, the semen is driven forward by contraction of the whole perineal group, aided by the muscular fibres of the urethra.

The semen is a composite fluid, made up of the secretions of the testicles, seminal vesicles, prostate glands, Cowper's glands, and the urethral crypts and follicles. It is a gray fluid, becoming gelatinous on ejaculation. If allowed to stand it becomes thin, and there settles from it an opaque deposit, made up of spermatozoa, over which lies a layer of about equal thickness of gray, translucent liquid. The characteristic odor of semen is probably given to it by the prostatic secretion. It resembles that of a raw potato. Spermatozoa at the time of ejaculation and for about twenty-four hours afterwards, if evaporation is prevented, should be in active motion. When the semen is deposited in the female genital tract, spermatozoa live for many days. After standing for two or three days, healthy semen deposits the spermatic crystals. The amount discharged at one orgasm is from one to two drachms, though this quantity is subject to marked variations.

The nerve-centres for erection and ejaculation are situated in the lumbar cord, the fibres passing outward from the erector centre being termed nervi erigentes.

The erector centre may be stimulated by reflexes from the genitalia or from regions associated by nerve anastomosis, by the direct action of the brain, or by injuries or diseases of the spinal cord. Familiar examples of erection from reflex action are afforded by the morning priapism incident to a full bladder; by the continued erection sometimes associated with prostatic calculus or with inflammation of the posterior urethra; and by the tendency to local congestion exhibited with balanoposthitis. The effect of sights, sounds, odors, or mental conceptions upon the erector centre is too well known to require comment. After fracture of the lower dorsal spines priapism may last for weeks.

Before considering the question of impotence it is well to know what constitutes an average amount of sexual strength. A man between his twentieth and fiftieth year, who has no drain upon his system, such as is required by unusual business anxieties, or such as results from grief, disappointment, etc., should be able to have intercourse about twice a week without experiencing any sense of fatigue or exhaustion. Idiosyncrasy, surroundings, or habits of life may so affect the individual that a much more moderate indulgence would be hurtful. Thus those of lowered vitality from excessive work, deficient food,

or organic or functional diseases may find indulgence to the extent above given highly injurious or even impossible, while the vigorous, full-blooded man, whose life is spent mainly in the open air, may far exceed this limit. The gauge as to the healthful limit of intercourse should be the sensations experienced afterwards. These should be rather of increased power, both physical and mental, than of exhaustion.

Erections may take place shortly after birth. The power usually departs about the sixty-fifth year, though it is often retained ten or fifteen years longer; it may be lost as early as the fiftieth year.

IMPOTENCE

From a clinical standpoint impotence may be classified as follows: (1) organic impotence; (2) psychical impotence; (3) atonic impotence.

Organic impotence implies the existence of appreciable lesions which interfere with function. These may involve the spinal cord, producing sclerotic changes either in the lumbar centres or in their afferent or efferent nerve-fibres. Thus, in lumbar ataxia, in syphilis of the cord, and in some cases of myelitis, impotence is sometimes an early symptom of the nerve-affection. This is comparatively rare.

The majority of cases of organic impotence depend upon malformation of the external genitals. This malformation may affect the penis, the testicles, both these organs, or the surrounding parts. The penis may be absent, may be rudimental, may be deformed, may be hypertrophied, may be multiple. If the organ is absent or exists simply as a rudiment, cure is hopeless. If the mechanical impediment to coitus is depended upon the small size of a penis which is normal in other respects, the case is not beyond help, since it has been shown in several instances that use has been quickly followed by an increase in growth. Thus, Wilson observed a man of twenty-six years whose penis before marriage was not larger than that of an eight-year-old child. Two years after marriage this organ had reached its normal size. In the treatment of impotence in patients with organs perfectly formed but markedly undersized, the application of a suction apparatus may be beneficial. This consists of a cylinder which is fitted over the penis and from which the air can be exhausted; as a result there is venous congestion, with temporary increase in the size of the organ. It is stated that this increase will become permanent if the treatment in continued a sufficient length of time.

The abnormal size of the organ may be an impediment to coitus, but only relatively so. Sometimes the penis is congenitally adherent to the scrotum, or is fixed to the groin or the belly as the result of cicatricial contraction. Here plastic operations will be necessary, according to the special indications of the case.

Hypospadia is a frequent cause of impotence, since the downward curve of the organ is so greatly exaggerated during erection that intromission is impossible. Wounds and lacerations of the floor of the urethra, sometimes internal urethrotomy, will produce the same incurvation.

Fibrous or cartilaginous indurations of either the sheath of the penis or the erectile tissue materially interfere with coitus, not only because of the distor-

tion which always becomes manifest on erection, but because the erectile tissue anterior to this point of induration remains entirely flaccid. These indurations are irregular in their distribution, and are common in the rheumatic and the gouty.

Deeper fibrous indurations, also interfering with function, not infrequently develop after gonorrhœa, and in some cases syphilis seems to be a factor in the growth of these lesions. When they appear in the form of gummata their specific origin is sufficiently obvious. Calcification sometimes takes place.

The treatment of this condition is unsatisfactory. Gummata can be made to resolve under specific treatment. The hard nodulations and indurated plaques which are observed in gonorrhœa or in gout, or which come without obvious cause, are extremely obstinate. Massage and inunctions of mercury should be employed, together with pressure, which is best applied by means of a thin rubber bandage. The prognosis as to cure must always be extremely guarded.

Aneurismal dilatations of the corpora cavernosa, whether congenital or traumatic, may mechanically prevent coitus. Relief is here obtained by the application of firm rubber bandages or supports.

Varix of the dorsal vein of the penis, though it may attain large dimensions, rarely produces functional disturbance. If it does, excision is the proper remedy. A similar condition of the lymph-vessels may be cured by excision, or by the less radical means of passing a seton through the vessel. A tight frænum should be remedied by incision.

Tumors or swellings about the genitalia may mechanically interfere with function. Thus, elephantiasis of the scrotum, enormous œdema of the prepuce, huge scrotal hernias, and immensely protuberant bellies, large scrotal tumors, muscular contractures, hydroceles, all may render coitus well-nigh impossible.

Malformations and diseases of the testicles may also produce impotence. Such deformity is not necessarily attended with any malformation of the penis, though this is the rule.

In anorchidism—that is, congenital absence of the testicles—impotence is complete. Cryptorchids (those whose testicles have not descended) are usually sterile, but not impotent. Removal of both testicles is ultimately followed by impotence, but this may not come on for some years.

Disorganization of the testicular structure either from inflammation or from tumor-growths is also followed by the loss of sexual power. If the inflammation is confined to the epididymis, however, as in the case of epididymitis, the glandular structure of the testes remaining intact, sterility follows, but there is no loss of sexual strength. Syphilis, tubercle, sarcoma, carcinoma, even though they involve but one testicle, are sometimes associated with impotence. The chronic congestion and slow atrophy incident to pronounced varicocele are not infrequently followed by impotence long before gross changes in the testicle are noted.

Psychical Impotence.—In this form of weakness the sexual organs are normally formed, and erection is possible, but is not properly under the control of the will. At times such patients have vigorous erections. These occur in the morning and on comparatively slight provocation. Under certain circumstances, and usually at times when this failure is most mortifying, erections

fail utterly, or, at most, are so feeble as to be of no service. This form of impotence not infrequently attacks the newly married, who fancy that they suffer from some form of sexual weakness incident to early self-abuse. It is sometimes due to a mental impression produced by failure incident to fright, disgust, or other emotions at the first attempt.

Treatment.—The treatment of these cases of psychical impotence should be one calculated to make a strong impression upon the patient's mind. He must be examined with the utmost thoroughness both locally and generally. All causes of local irritation must be removed and every effort made to improve his general health; he should be assured that his weakness is merely temporary and that cure will certainly result. Such patients have generally read pernicious literature, and have usually consulted charlatans: hence they need to be disabused of the teaching that masturbation indulged in moderately and for a short time invariably produces disastrous results.

In addition to the general hygienic directions, including regulation of the diet, attention to the bowels, and exercise, some medicine should be given to these patients, and this should be one appropriate to their general condition, or, if the health is perfect, one which has a tendency to act as an excitant on the spinal centres. Perhaps the best prescription is the following:

℞ Strychninæ sulph., gr. $^1/_{20}$;
Phosphori, gr. $^1/_{100}$;
Damianæ ext., gr. iii;
M. et ft. pil. no. i.
S.—One pill three times a day.

Under some circumstances moderate stimulation by means of Burgundy or champagne may be beneficial, since the patient is often entirely cured after one successful effort. Absolutely forbidding intercourse acts at times as an excellent stimulus. Patients suffering from this form of impotence should be especially cautioned against trials of their powers with prostitutes, since the circumstances of these trials are little conducive to a normal degree of sexual excitement.

The term RELATIVE IMPOTENCE implies lack of ability to perform the sexual act with certain partners, while with others full strength may be preserved. No rule can be laid down for the management of such cases. Each must be conducted in accordance with its merits, the physician always throwing his influence on the side of morality. Much can sometimes be done by strong mental impression, usually accentuated by the administration of drugs. In many cases impotence upon the part of the man is due to the frigidity of the woman, who does not realize the profound effect of her attitude. Perhaps the best plan in these cases is to advise the man to shun the society of other women, to live well, work little, exercise much.

ATONIC IMPOTENCE.—Under this heading are included those cases of partial or complete impotence which are due to a weakened condition of the lumbar centres. When these centres are in their normal condition, erection should be vigorous, and coitus should be continued for from three to five minutes before ejaculation, and after ejaculation there should not be immediate subsidence of erection. In many healthy young men the erection can be maintained until two emissions have taken place.

In atonic impotence (1) erections may be vigorous, but ejaculations may be premature, occurring on contact or even before, followed by immediate subsidence of erection; (2) erections may be weak or may be entirely wanting.

The atonic condition of the lumbar centres may be dependent on certain general conditions, such as anæmia, diabetes, uræmia, cholæmia, and rheumatism. Sometimes temporary impotence is one of the first signs of post-diphtheritic paralysis. Wasting diseases, such as consumption, are usually accompanied by this form of atonic impotence. Many drugs, if taken until their toxic effects are produced, occasion failure of sexual power. Thus, lead-poisoning, carbonic acid gas, carbon bisulphide, antimony, and particularly alcohol, tobacco, and opium, may cause complete loss of both power and desire. Impotence resulting from the excessive use of tobacco and alcohol often long outlasts the other bad effects after the habit has been stopped. Certain persons exhibit an idiosyncrasy towards tobacco, which, when taken in such moderation as to produce no constitutional effect, may destroy both sexual desire and power. It is alleged that the cigarette is particularly potent in producing this result.

According to Trousseau, coffee has marked anaphrodisiac effects, and may produce complete impotence. This observation is certainly not in accord with the experience of the majority of surgeons, at least so far as the moderate use of the drug is concerned. If taken in enormous quantities it may, of course, produce this result, but rather because of the general nervous breakdown than because of any special action on the sexual centres. Certain drugs given in physiological doses will produce a marked lessening of sexual power. The bromides are particularly depressing; cocaine is alleged to have this effect, and morphine in certain individuals is markedly sedative to the sexual centres.

In accordance with the degree of impotence the condition is said to be either irritative or paralytic.

In the irritative form the erections are either perfect or imperfect. The emissions are always premature, quickly followed by subsidence of erection. The sexual desire is strong.

In the paralytic form erections are absent or feeble, desire is wanting; during orgasm the semen drops from the flaccid penis, with little or no pleasurable sensation.

Of these two forms the irritative is the more common. The cause is in the great majority of cases a diseased condition of the prostatic urethra, the mucous membrane being exceedingly hyperæmic, or chronically inflamed, keeping the centres for erection and ejaculation in a constant state of reflex excitability. This condition of the prostatic urethra may depend upon—(1) gonorrhœal inflammation and its sequel, stricture; (2) excessive venery; (3) prolonged ungratified sexual excitement; (4) strongly acid or irritating conditions of the urine. Of all these causes, gonorrhœal inflammation and its sequel, stricture, are the most frequent. In most cases of acute gonorrhœa the prostatic urethra is involved to a very slight degree, and the disease, at least in this part of the tube, undergoes complete resolution. In a certain percentage of cases, however, the disease becomes firmly lodged in the prostatic follicles, utricle, ejaculatory ducts, seminal vesicles, or ampullæ of the vasa, manifesting itself only by an occasional apparently causeless outbreak in the form of an acute attack. As

a consequence of the continued irritation, the mucous membrane of the prostatic urethra undergoes catarrhal alterations, and the sensory nerve filaments so rich in this part of the tube are involved and reflexly excite the centres for erection and ejaculation. This inflammatory and hyperæsthetic condition of the posterior urethra is still further aggravated by the formation of a stricture.

Atonic impotence from sexual excess is most frequently observed among masturbators, if this habit can properly be classed as "sexual." In the recently married sexual excess is by no means uncommon, but shortly regulates itself. Occasionally it is continued for a long time, and then doubtless works permanent harm by producing a hyperæsthetic condition of the posterior urethra, and consequently one of the forms of impotence.

Masturbation as a cause of impotence is generally given prominence which is not deserved. This is a habit which practically all boys have had at one time. The popular belief as to the injury which even a slight indulgence in it may cause leads those who subsequently have sexual trouble to refer this back to self-abuse. Even when the habit is continued for years during the period of youth and early manhood it is often followed by no appreciable ill effects: at least such is the testimony of large numbers of medical students. It is, however, undoubtedly true that in certain instances, aside from the rooted conviction of the patient, irritative and paralytic forms of impotence can be referred directly to excessive masturbation. The physique and morale of a masturbator are popularly considered as almost pathognomonic. Thus, such patients are supposed to have muddy, pimpled complexions; a cold, moist surface; hollow, sunken, blinking, shifting, watery eyes; lustreless hair; a timid, constrained manner; stooping shoulders; a tendency to swallow frequently, particularly on being embarrassed; weak knees; a shambling gait; shrunken sexual organs, and a solitary disposition, with incapacity for any intellectual effort.

This description no doubt applies to certain aggravated cases. It may, however, be observed in neurotics who are not addicted to the habit, and an extreme degree of masturbation may coexist with the appearance and manners of perfect health.

Atonic impotence from prolonged and ungratified sexual desire is usually observed in men of neurotic temperament, particularly those coming from the rural districts, who, from the circumstances of their life, are exposed to sexual excitement, and who, either from moral reasons or for lack of opportunity, do not indulge in sexual intercourse. Many of these cases can properly be classed as masturbators, since the sexual centres finally become so irritable that even the mechanical frictions or jarrings, such as come from riding on horseback or in a jolting wagon, occasion emissions.

In these cases the condition of sexual neurasthenia is unusually well marked.

Since the ordinary lesion of atonic impotence, whatever its remote cause may be, is a hyperæsthetic condition of the prostatic urethra, it is not unreasonable to suppose that the irritation incident to abnormal conditions of the urine may excite a prostatic hyperæmia, resulting in the derangement of the sexual centres. That this is the cause of impotence associated with certain abnormal conditions of the urine cannot be positively asserted, since it is possible that the general condition which occasions the abnormal urine may also

operate on the centre presiding over erection. Thus, in complete impotence a careful examination of the prostatic urethra may fail to show the slightest sign of abnormal prostatic condition. In cases of oxaluria, however, the return of sexual strength is often coincident with the disappearance of calcium oxalate in the urine. The irritating effect of acid urine on the prostatic urethra is shown by the persistent priapism which sometimes accompanies acute attacks of gout, in which there is found a heavy deposit of uric acid.

Genito-Urinary Neuroses.—Atonic impotence is characterized by certain local and general symptoms, which Ultzmann has admirably described under the general heading of genito-urinary neuroses. He states that the symptoms incident to a hyperæmic or chronically inflamed condition of the prostatic urethra are almost identical with those observed in the female as the result of endometritis. Both the uterus and the prostate are richly supplied with nerves. In men the bladder and seminal vesicles and prostate receive filaments from the vesical plexus, which, in turn, is made up of anastomosing branches from the hypogastric branch of the sympathetic, together with branches from the sacral ganglia and from the pudendal plexus of the sacral nerves. This nerve-supply sufficiently explains why irritation of the prostatic urethra should excite such reflexes as pain passing down the inner surface of the thighs or referred to the hip, the anus, the hypogastric region, or the small of the back.

The general symptoms are those of neurasthenia. Loss of mental power, vertigo, headaches, shortness of breath, indigestion, palpitation, colic, cough, emaciation, wandering neuralgic pains, nervousness, and excitability,—these and many other symptoms of which neurasthenic females complain are duplicated in the male suffering from atonic impotence.

The urine in these cases is often abundant and of low specific gravity. Sometimes there is a transient glycosuria. In some cases the urine is alkaline when it is passed, owing to the presence of carbonates. On heating, the earthy phosphates are precipitated. Indican is observed particularly in those given to sexual excess. Transient albuminuria is sometimes noted. Calcium oxalate frequently appears in great excess. The amorphous crystalline salts of lime and magnesia are also to be found, together with a few spermatozoa.

The sensory neuroses present an almost infinite variety. The usual symptoms complained of are a sensation as though fluid was trickling through the urethra; a tickling and burning feeling at the meatus; neuralgic, aching, or burning pains referred to the testicles, anus, inner surface of the thighs, hypogastric region, small of the back, or any of the regions innervated by branches communicating with the hypogastric and sacral plexuses; pain in the testicles and burning in the meatus after ejaculation; and extreme sensitiveness to the passage of instruments. In aggravated cases the urethra becomes anæsthetic, and the penis feels cold, is shrivelled, and is sometimes so non-sensitive that even application of an electric brush occasion no pain.

The motor neuroses of the urinary and genital systems may take the form of over-action or of paralysis. Vesical irritability is sometimes manifested by paroxysmal dribbling or even complete stoppage of the urine, occasioned either by a lack of contraction of the smooth muscular fibres or by spasm of the compressor urethræ. So-called stuttering urine may be due to the same cause.

When the detrusors of the bladder are involved in over-action there is difficulty in retaining water. Urination is frequent and urgent, and is usually not associated with pain, but sometimes there is marked tenesmus. Paralysis of the sphincters or detrusors is extremely rare; in the one case it would occasion dribbling of the urine and in the other retention. The motor neuroses of the sexual system may be manifest in the form of priapism, or of partial or complete impotence, often associated with involuntary seminal emissions and spermatorrhœa. Priapism is observed only in the early stages of acute involvement of the prostatic urethra; impotence is common in chronically inflamed conditions. The frequent pollutions complicating it are due to spasm of the detrusors of the seminal vesicles and the vasa deferentia. Spermatorrhœa or dribbling of the semen without the sensation of an orgasm is due to paresis of the muscular fibres of the ejaculatory ducts.

The secretory neuroses of the genital system are manifested in the form of polyspermia, or ejaculation of abnormal quantity of semen; aspermia, or absence of semen; or prostatorrhœa, a discharge made up of the secretions of the prostatic glands, the glands of Cowper, and the urethral crypts and follicles.

The Diagnosis of Atonic Impotence.—A careful history will often indicate whether impotence is due to psychological influence, to organic changes, or to exhaustion of the lumbar centres. Examination should be made not only of the sexual organs but also of the heart, of the lungs, and of the system at large. Examination of the urine should never be omitted; the total quantity in the twenty-four hours, the specific gravity, the reaction, the deposit, the presence or absence of abnormal constituents, must all be carefully noted. Microscopic search will determine whether or not pus is to be found. The source of this pus must be discovered in the method described when considering the treatment of posterior urethritis. The anus should be explored carefully, since lesions in this region may excite reflexes which are referred to the genital tract.

Finally, the sexual organs must be carefully examined; the testicles are palpated, and their size, position, consistence, sensitiveness, and the presence or absence of swellings and new growths are noted. The penis is similarly examined, its circumference behind the glans recorded, and the urethra carefully palpated for indurations along its track. The prepuce is subjected to careful scrutiny, the meatus is inspected, and finally the urethra is explored exactly as in searching for strictures. In many of these cases spasmodic contraction of the compressor urethræ muscle is particularly marked. A full-sized sound passed to the membranous urethra and kept gently pressed against its anterior opening will finally slip through, not with a jump, but rather as though an attempt were being made to pass it through a tight, flexible tube without previously lubricating it. Sometimes it seems to be drawn in with a swallowing motion. During the introduction of the instrument not only should the points of resistance to its entrance be noted, but also areas of unusual tenderness. The posterior urethra is extremely sensitive; in cases of the paralytic type, however, the passage of a sound is absolutely painless.

If the meatus is so narrowed that it will not admit a full-sized sound it should be cut. Urethroscopic examination is rarely necessary in these cases, at

least until the failure of ordinary treatment suggests the possibility of some unusual pathological condition, such as polypoid growth.

An examination thus conducted will show a hyperæmic or inflammatory condition of the posterior urethra, either associated with stricture or other obstructive lesion, or simply remaining as the result of repeated prolonged congestion or previous acute inflammation.

The prognosis of atonic impotence is good, except in the most advanced cases. When strictures or granular patches in the anterior urethra are the exciting causes, the cure of these is followed by the disappearance of the symptoms of impotence.

When the symptoms are due to the persistence of a posterior urethritis, local applications are curative. When impotence is caused by impaired health, the outlook is favorable, provided the general condition can be improved. Even though erections are entirely absent at times when they are most desired, or are of such short duration as to be of no practical service, if the patient has voluptuous dreams with erection, and particularly if he has an occasional morning erection, the chances of ultimate cure are good. The prognosis is bad only in such cases as have no erection at any time, the semen dribbling without pleasurable sensations, and the penis being cold, shrivelled, and non-sensitive.

Treatment.—The treatment of atonic impotence must be both general and local. The daily life of the patient should be carefully regulated. The hours of sleep, the diet, the amount and kind of exercise, should all be prescribed. The bowels should be kept regular, and general treatment should be instituted when this is required to combat the pathological conditions of the urine. During treatment the patient must be particularly cautioned against venereal excitement of any kind, whether from reading, conversation, or associations, and against testing the efficacy of his treatment by an occasional trial of strength.

All sources of reflex irritation must be removed. Fissures or hemorrhoids in the rectum, phimosis, or narrow meatus should receive prompt surgical treatment. Some cases of impotence have been cured by the removal of a hemorrhoidal mass, by the slitting of the meatus, or by treatment directed to the destruction of lumbricoids or ascarides. Even a moderate degree of varicocele should be remedied either by a suspensory bandage or by operation.

If in the course of treatment the thoughts are, in spite of every effort, turned to sexual topics, the patient should be instructed to counteract this tendency in its very beginning by vigorous and prolonged exercise and cold baths.

The local treatment has for its end the restoration of the entire urethra to a normal condition. Strictures must be cured by section or dilatation, granular patches healed by applications through the endoscope, and hyperæsthetic and inflammatory conditions of the posterior urethra treated by irrigation, instillations, and the passage of full-sized cold steel sounds, or by the use of the psychrophore.

The sound should be introduced every third or fourth day and should be of full normal calibre. When the urethra is extremely hyperæsthetic, injections of eucaine, first into the anterior urethra, then into the posterior part of the canal by means of an instillator, will render instrumentation comparatively painless.

When there are distinct evidences of congestion or inflammation in the posterior urethra, in addition to the sound, irrigation and instillation will usually be necessary before cure can be accomplished. (See Treatment of Chronic Posterior Urethritis.)

When inflammation is absent, or after it has been cured, if hyperæsthesia still persists, this is best combated by the prolonged application of cold. The passage of a cold sound accomplishes this end in an imperfect way, since the metal is soon heated. The psychrophore (Fig. 235) will, however, permit of a continuous cold application for as long a period as is desired. This instrument is made in the form of a hollow sound, through the curved extremity of which a stream of water of the desired temperature constantly flows. It is so devised that the sheath of the instrument which passes through the anterior urethra is not kept cold by the liquid, which flows through pipes contained in

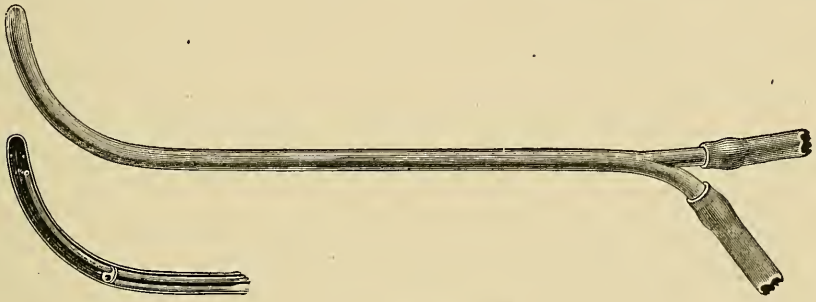


Fig. 235.—Psychrophore.

the sheath, but separated from its walls by air-spaces. It is only in the terminal three inches that the water is allowed to come immediately in contact with the walls of the instrument.

The psychrophore should be as large as the normal calibre of the urethra. It is introduced until its curved portion occupies the membranous and prostatic urethræ; then a current of water of the desired temperature is allowed to pass slowly through it, thus maintaining the chamber at its end at about the temperature of the water. In cases of hyperæsthesia attended by the irritative form of atonic impotence, cold water is most serviceable. The temperature of this should be between 40° and 50° F., and the treatment should be kept up for from five to ten minutes every second or third day. In the paralytic form of atonic impotence hot water from 106° to 110° F. should be chosen.

Heat or cold may be applied through the rectum in the form of injections, or a rubber bag introduced within the grasp of the sphincter.

Rectal injections are so planned that the solution of choice (sodium chloride solution, nine-tenths per cent.) is thrown upward in a forcible stream against the prostate, and is allowed to escape immediately without distending the bowel. This end is readily accomplished by the instrument pictured in Fig. 203. The selection of heat or cold will depend upon the type of disease and the sensations of the patient. At least two quarts of solution should be used daily. Dry heat

or cold through the rectum is readily applied by means of a modified Barnes's bag inserted into the rectum and distended with either hot or cold water. This method of treatment is to be commended since it adds to the beneficial effects of temperature those incident to pressure.

When by the means already described urethral hyperæsthesia has been entirely subdued and yet impotence still persists, other methods of treatment must be employed to restore power to the weakened centres and also to the muscles concerned in erection and ejaculation. Full doses of strychnine are advisable in these cases, and particularly strychnine in combination with phosphorus and damiana. Massage and general electricity are useful.

The needle spray applied once a day to the external genitalia at the time of the morning bath is tonic and stimulating. The water should be driven forcibly against the inner surfaces of the thighs, the hypogastric region, the buttocks, and the small of the back, and should be alternately as hot as can be borne and as cold as possible. The applications should be continued for from two to five minutes.

Electricity is one of the most valuable means of stimulating the sexual centres. Both the galvanic and the faradic current seem to be of value. It is employed not only as a general nerve tonic, but also as a means of directly exercising the perineal muscles concerned in erection. The current should be first applied to the spine, and then used locally. The positive pole is placed over the lumbar region; the other is carried to the perineum, the anus, the hypogastric region, or the prostatic urethra, and swept over the external genitalia, the buttocks, and the inner surface of the thighs.

The rectal electrode is serviceable in cases of imperfect erection and loss of power of ejaculation; it is particularly valuable because by means of a slowly interrupted current it exercises the entire perineal group of muscles. The important part these muscles play in erection has been shown already, and restoration of their vigor by the use of electricity may be followed by complete recovery of sexual strength. The application should last from fifteen to twenty minutes and be repeated daily for several weeks or months.

The urethral electrode allows the current to be applied directly to the prostatic urethra. Both galvanic and faradic currents are employed, the gauge as to strength usually being the sensation of the patient. An electrode properly placed and conveying a slowly interrupted current strongly exercises the sphincter of the bladder, the compressor urethræ, and the unstriped fibres of the prostate, probably including those of the ejaculatory ducts: hence in cases of spermatorrhœa this treatment is particularly serviceable.

In some cases which do not yield to other treatment, a complete course of hydrotherapy, including, as it does, change of air, surroundings, and occupation, is sometimes advisable, or, in place of this, prolonged out-door but not solitary life.

Two of the symptoms of atonic impotence are so conspicuous as to deserve separate consideration: these are prostatorrhœa—that is, intermittent discharge of prostatic fluid from the urethra—and spermatorrhœa, or involuntary loss of semen.

Prostatorrhœa is characterized by a discharge during defecation, after

urination, and at times of sexual excitement, of a white-of-egg-like substance from the urinary meatus. This same substance may be caused to flow from the meatus by pressure upon the prostate through the rectum. Microscopic examination of the discharge shows that it is made up of leucocytes, cylindrical epithelium, and concentric amyloid concretions; Böttchers sperm crystals and casts of the prostatic ducts, closely resembling renal casts, are also found. Blood is rarely present.

Prostatorrhœa is dependent on a chronic catarrhal condition of the prostate, involving both ducts and follicles. Gonorrhœa and prolonged ungratified or unnaturally gratified sexual excitement most often produce this catarrhal condition. On examination of the prostate per rectum it will not usually be found materially increased in size, although occasionally the nodular outline indicative of follicular prostatitis can be felt. The most prominent symptoms of this condition are—(1) A marked condition of sexual neurosis, perhaps a reflex from the catarrhal condition, usually aggravated because the patient believes that the discharge is semen and that thus his strength is draining from him. (2) A discharge at stool and after urination of viscid prostatic mucus. The hypersecretion is going on steadily, and the fluid is squeezed from the gland by the passage of hard fecal masses and by the muscular contractions accompanying the conclusion of the act of urination, and is allowed to pass forward by the relaxation of the compressor which occurs in both urination and defecation. In some aggravated cases the compressor urethræ muscle becomes so weak that the discharge will flow forward almost constantly. If many spermatozoa are found in the discharge, the case must be regarded as one of spermatorrhœa. (3) Frequency and some urgency in urination, tickling or aching sensations in the prostatic urethra, and reflex pains in the back, return, hypogastrium, and down the inner surface of the thighs. (4) Partial or complete impotence. Exceptionally, beyond the prostatic discharge, there are no symptoms.

Even when habitual masturbation causes prostatorrhœa, the prognosis is fairly good, provided the paralytic form of impotence has not been reached and the patient has some strength of will on which to build.

Treatment.—The treatment is especially that directed to the cure of congestion or inflammations of the posterior urethra. When a depressed condition of the system or irritating urine seems to be the cause of prostatorrhœa, corrections of these departures from health may be followed by prompt cure.

It is particularly important that the bowels should be kept open. Paraffin oil, cascara, podophyllin, magnesium sulphate, and sodium phosphate are the medicaments of choice. Both exercise and diet must be carefully regulated. Horseback or bicycle riding should be forbidden only to those whose symptoms after a trial are made distinctly worse. Often these exercises provide a species of massage for the prostate which acts most beneficially upon it. Prolonged, ungratified sexual excitement will render abortive all treatment.

When there is pus in the discharge or in the shreds found in the urine, the treatment is that appropriate to posterior urethritis.

The medical treatment is of minor importance, but should none the less receive attention. When the inflammation is one of long standing, stimulants may be required. Here oil of sandalwood, or one of its esters, in ten-minim

doses three times a day, taken one hour after meals, will be of great help. Cubebs, copaiba, turpentine, and cantharides, the latter in small doses, are all useful. When the bladder is irritable, belladonna, five drops of the tincture three times a day, is beneficial. When the urethra is especially hyperæsthetic, and particularly in cases of marked sexual neurasthenia, potassium bromide, administered in ten-grain doses three times a day, may quiet the nervous symptoms. As a rule, tonics, compound syrup of hypophosphites in teaspoonful doses, emulsion of cod-liver oil with iodide of iron, and iron and nux vomica, should be recommended. We have found hyoscine and hyoscyamine sulphate particularly efficacious in the non-inflammatory forms of prostatorrhœa.

It is upon local treatment, however, that most reliance must be placed. This consists in the use of steel sounds, the psychrophore, the prostatic dilator, the rectal bag, the rectal douche, irrigations, and instillations.

Instillations in these cases should be more astringent than in an ordinary inflammatory case: thus, fluid extract of hydrastis pure or zinc sulphate, twenty grains to the ounce, may be employed.

The prostatic dilator (see Figs. 6 and 7) is of service. The solutions of choice and the method of instrumentation have been given. (See Chronic Posterior Urethritis.) Stretching by means of the dilator should be carried as high as No. 36 of the French scale and not higher than No. 44. Full dilatation of the prostatic urethra by means of ordinary sounds is impossible, since an instrument of sufficient size to overstretch the membranous urethra fits loosely in the wider prostatic portion of the tube.

Perineal counter-irritation is not without its helpful influence; it may be applied daily by freezing a spot the size of a dollar with ethyl chloride.

Electricity is sometimes a useful agent in prostatorrhœa. The galvanic current is most popular, one pole being applied to the lumbar region, the other to the prostatic urethra.

Usually it is best strictly to interdict intercourse; though when prostatorrhœa occurs in married men as the result of long-continued excess it is wise for a time to allow of moderate indulgence, since otherwise the local congestion incident to prolonged excitement without gratification might counteract the effect of treatment. The advisability of allowing moderate intercourse must be determined by the immediate effect; thus, if the discharge is increased, and particularly if the patient feels exhausted and suffers from lumbar pains, intercourse must be forbidden.

Under proper treatment recovery may result in from one to three months, though in some cases a much longer period of time is required. Certain cases are aggravated by local treatment. Under these circumstances it is advisable to make a complete change of life and surroundings. An active open-air life will sometimes be followed by ultimate cure.

Involuntary Seminal Emissions.—These may be due to erotic dreams, or may be occasioned by a local hyperæsthesia so marked that stimuli too feeble to produce any effect in health become sufficient to excite ejaculation. The involuntary emission may occur at night or in the day, and the semen may escape intermittently in the form of pollutions or as an almost constant flow.

Nocturnal Pollutions.—In continent men it is entirely compatible with health

to have nocturnal pollutions as frequently as once a week. When during the waking hours there has been prolonged sexual excitement, these pollutions may occur much more frequently, two or three times a week, and yet indicate no abnormal local or general condition. It is, however, by no means rare to find continent men who have no pollution for weeks or months at a time; it is especially in those who are kept constantly occupied both in mind and in body that this is observed. After prolonged exertion, either mental or physical, it is not uncommon for two or three emissions to occur in a single night. The pollutions may be unattended by voluptuous dreams, and may occur with the penis flaccid. It is possible for the variations just named to be found within the limits of perfect health.

The gauge as to whether the loss can be considered indicative of either local or general weakness is the condition of the patient. If aside from imaginary sufferings these pollutions are followed by weakness, backache, and mental depression, if they are habitually frequent, and particularly if they are associated with sexual weakness or impotence, they must be regarded as an index of disordered function. At first nocturnal pollutions, even though they occur with extreme frequency, are usually associated with full sexual strength; later, as the excitability of the ejaculatory centre becomes weakened, there is usually developed a more or less profound form of sexual weakness.

Diurnal pollutions indicate a degree of sexual weakness much more marked than do even excessive seminal losses occurring during sleep. In these cases the slightest psychical or physical stimulus is often sufficient to excite emission. The presence of women, the jarring of a wagon, manipulations necessary for cleaning the foreskin, or even examination of the skin surface around the genitalia, may occasion pollutions. The erections are usually imperfect, the voluptuous sensations are blunted, and immediately after emission there is subsidence of the erection.

Spermatorrhœa.—This condition is characterized by oozing out of the semen without erection or pleasurable sensation. It is occasioned by erotic thoughts, or by light mechanical stimuli, or may occur independently of these causes, the semen escaping with the urine or during defecation as in prostatorrhœa.

Spermatorrhœa in the sense of a constant flow of semen from the urethra is extremely rare. In vigorous men much given to sexual excess who become suddenly continent, a whitish discharge is observed, which on examination is found to be swarming with spermatozoa. This is a transitory condition unassociated with impotence, and with but a moderate degree of sexual hypochondriasis. Slight and intermittent spermatorrhœa is comparatively common in chronic posterior urethritis, even when there is no appreciable functional weakness.

A typical sufferer from spermatorrhœa represents the most aggravated form of impotence. Both desire and the power of erection are usually lost, and voluptuous sensations are excited only by the strongest stimuli.

The diagnosis of spermatorrhœa must be founded on microscopic examination. A few spermatozoa in a mucous discharge do not indicate any pathological condition. If great numbers are constantly present in the urine and in

the discharge occurring after defecation or urination, it may be assumed that there is a condition of true spermatorrhœa.

Treatment.—The treatment of involuntary seminal emissions is that appropriate to atonic impotence, since both these conditions are symptomatic of an irritable condition of the lumbar centres.

The treatment of nocturnal pollutions must be conducted upon rational principles. First, it must be determined whether such pollutions indicate an abnormality. Usually the patients applying for the relief of this condition have seminal losses not more frequently than is consistent with perfect health. When the loss is excessive, or even when it is strictly confined within normal limits, if the patient is markedly hypochondriacal, a vigorous treatment should be instituted. General hygienic directions are given; the patient is particularly cautioned against sexual excitement. By means of a saline or other mild laxative the bowels are opened at night before retiring. The bed should be hard, the covering light; sleeping in the dorsal decubitus should be avoided by tying a towel around the waist with a knot over the spine. An alarm-clock is set to ring about four hours after the time of going to bed, the patient then rising and passing water. Before going to bed, light calisthenics to the point of perspiration, cool sponge bath, and brisk rubbing down are advisable.

When in spite of these precautions erections and emissions occur, an anti-pollution ring may be worn. This is designed to fit comfortably about the penis when the organ is in its flaccid condition; when it becomes erect a number of sharp teeth dig into the skin and, by the pain they excite, wake the patient. All sources of reflex irritation must be sought for and removed. Medication directed to subduing the irritability of the lumbar centres is sometimes most serviceable. Potassium bromide, from thirty to ninety grains at bedtime, is temporarily useful. Atropine, one three-hundredth of a grain three times a day, or twice this quantity given at bedtime; hyoscine, one one-hundred-and-fiftieth of a grain; lupuline, one-twentieth of a grain three times a day; and monobromate of camphor, five grains three times a day, are all serviceable; hyoscyamine is almost a specific.

The treatment of diurnal pollutions is conducted on the same general principles as that of atonic impotence, except that, as this symptom usually denotes an advanced catarrhal alteration of the prostatic urethra, strong applications to this portion of the canal are usually necessary. In addition to the various instillations the solid stick of silver nitrate may be used advantageously. The hot rectal douches, the needle spray, electricity, and the treatment appropriate to nocturnal pollutions are applicable in these cases.

In cases of seminal incontinence (spermatorrhœa) the treatment should be directed towards restoring tone to the paretic vessels and revitalizing the exhausted lumbar centres. Of the drugs employed, strychnine, one-twentieth of a grain four times a day; damiana, five grains three times a day; phosphorus, one-hundredth of a grain three times a day; fluid extract of ergot, a teaspoonful three times a day; and arsenic trioxide, one-fortieth of a grain three times a day, are valuable. Electricity is particularly serviceable. The psychrophore, hot rectal douches, strong posterior applications, particularly the solid stick of

silver nitrate, or instillations of pure iodine or of iodine and carbolic acid mixed, will give the best results.

Many cases of sexual weakness are made worse by treatment. If after one thorough trial of methods which careful examination has shown most likely to be successful there is no improvement, local treatment, in the absence of local lesions, should be abandoned, the physician devoting his whole attention to the improvement of the general health of the patient.

Priapism.—Persistent erections unaccompanied by sexual desire, at times extremely painful, and interfering with the function of urination are usually expressions of spinal lesion, particularly that due to syphilis, to beginning sclerosis, or to the infiltration of leukæmia. Cerebellar hemorrhage and spinal trauma sufficiently severe to cause paraplegia also produce this symptom. Intermittent priapism, usually annoying rather than painful, is a frequent accompaniment or sequel of prolonged mental strain in neurasthenic men.

The prognosis is grave from the standpoint of the causative lesion.

The treatment of the intermittent neurasthenic forms of this affection should aim at rest and improvement of the general health. If a thorough examination excludes central nervous lesions, then patients can be assured that the symptom which to them is often most alarming has no serious significance, and that local treatment is not indicated. Small doses of hyoscyamin sulphate, gr. $^1/_{200}$, twice daily, are often serviceable, but bromides or other depressants are, as a rule, distinctly hurtful. Exceptionally a local lesion such as chronic posterior urethritis may cause intermittent priapism, and in such case direct treatment is indicated. Even in the absence of local lesions, the passage of a sound may be helpful. The observance of general hygienic regulations and treatment directed to the relief of gout, rheumatism, or other systemic condition which may require medication are followed by cure.

Priapism dependent upon syphilis of the cord calls for intravenous administration of the arsenical preparations and massive doses of mercury and the iodides. When, because of leukæmic infiltrate or pressure on the cord from unremovable tumor, the erection becomes persistent and hurtful and section of the pudic nerves may be needful to give relief.

Impotence of the Female

Impotence in the female, in the sense of inability to accomplish the sexual act under normal and lawful conditions, may be classified under the following headings: (1) intromission of the male organ is impossible; (2) intromission is possible, but either excites pain or fails to cause orgasm.

Intromission of the male organ may be prevented by congenital or acquired obstruction, or by obliteration of the vulva and vagina. The congenital anomalies may appear in the form of absence of the vagina, extreme narrowing, division into two parts, each too small to allow of intromission, or opening in abnormal positions, as, for instance, into the rectum. The vulva may be obstructed by adhesions, by hypertrophy of the labia or clitoris, or by a rigid or imperforate hymen. Acquired obstruction may depend upon cicatricial contraction, inflammatory swelling, new growths, or hypertrophy of the parts.

The treatment of impotence dependent upon congenital absence of the vulva or vagina is of little avail. Cases of imperforate hymen, adherent labia, or mechanical obstructions, as from swellings or tumors, can be remedied only by surgical operation.

Intromission may be mechanically possible, but may be resisted or entirely prevented because of the pain occasioned by the attempt. Thus, acute inflammations about the vulva, vagina, uterus, or ovaries will render sexual approach extremely painful; urethral caruncles, urethritis, fissures of the neck of the bladder, hemorrhoids or rectal fissures, ulcers and displacement of the womb, inflammation of the Fallopian tubes, and disease or prolapse of the ovaries, are frequently observed as causes of this condition.

Usually, on account of the pain, the perineal muscles become spasmodically contracted and intromission is impossible. Sometimes this spasm does not occur until entrance is accomplished, in which case the male organ may be so tightly imprisoned that release is accomplished only when the muscles of the female are relaxed by ether. It is customary to class vaginismus among the pure neuroses. A careful search will, however, in almost every case reveal an inflammatory area from which the reflex starts. In most of these cases the origin of the reflexes is to be found in fissures in the neck of the bladder; urethral caruncle and urethritis are also frequent causes of vaginismus. As a very rare exception the only pathological condition to be detected is an apparently causeless hyperæsthesia of the vaginal mucous membrane.

The treatment of vaginismus depends for successful issue upon the skill and thoroughness with which local examination is made for the source of the reflexes. In the absence of any cause discoverable by palpation or inspection of the genitalia, a thorough endoscopic examination of the bladder is indicated.

The cure of vaginismus depends upon the cure of its exciting causes. Where, as is usually the case, there are found several abnormal conditions, each of which may possibly be responsible, such as extensive fissure in ano, chronic endometritis, and granular urethritis near the neck of the bladder, all these abnormal conditions should be remedied.

In the absence of any local pathological condition, vaginal douches of hot one per cent. soda solution, followed by the application of ten per cent. cocaine solution to the vulva and the lower portion of the vagina, may render introitus comparatively painless. These patients, belonging as they do to a neurotic type, should receive treatment appropriate to their general condition.

STERILITY

Sterility in the male is that condition in which there is loss of procreative power. This necessarily implies absence of living spermatozoa, since these are the elements essential to impregnation, but it does not imply failure of power in sexual congress.

Failure to bear children on the part of married women is due in a certain proportion of cases to sterility of the husband. The definite percentage cannot be given, since the whole subject is somewhat obscure. Thus, it is well known that a marriage may remain barren, but that each partner of this marriage, after other sexual relations, may become a parent. The percentage of sterile

husbands in childless marriages has been variously calculated at from five to twenty.

The composition and physical qualities of normal semen have been already described. The total quantity and the number of spermatozoa are markedly diminished by sexual excess and wasting diseases. Sterility may be manifest by—

(1) Aspermia, entire absence of semen.

(2) Oligospermia, diminution in the quantity of semen.

(3) Azoöspermia, absence of spermatozoa.

Aspermia is a condition in which no seminal fluid is ejaculated, though the act of coitus may be performed normally in other respects. Aspermia may be due to imperfect coördination of the muscles of ejaculation; sometimes it is an expression of sexual weakness. In this case, though there is no escape of semen during orgasm, it may subsequently drop from the end of the flaccid penis.

More rarely there may be seminal emissions only during sleep, prolonged and repeated efforts utterly failing to produce emission during or after coitus. In this case incoördination probably involves the muscles which force the seminal fluid into the prostatic urethra and the dilatation of the bulb, or failure in emission may be due to sensory paralysis.

As a modification of this form of aspermia, patients are seen in whom ejaculation sometimes takes place during coitus and sometimes cannot be excited.

The common cause of aspermia is obstruction of some portion of the urethra. This obstruction may be congenital or acquired. The acquired form may be due to traumatism or inflammation. When inflammation has attacked and destroyed the greater portion of the secreting substance of the prostate, and has blocked the ejaculatory ducts, after orgasm there will be a discharge of two or three viscid drops, representing the secretion of Cowper's glands and the urethral crypts and follicles. Tuberculous infiltration, malignant degeneration, the pressure of tumors, tight stricture, or the blocking of the passage by a prostatic or cystic calculus may produce aspermia. Injury to the ejaculatory ducts, without involvement of the prostate, will cause diminution in the quantity of semen secreted and absence of spermatozoa, but not aspermia, since the prostatic secretion is ejaculated and presents at least the gross physical attributes of normal semen.

The term false aspermia, or malemission, is sometimes employed to designate that condition in which semen is discharged into the urethra but does not reach the meatus, either passing back into the bladder to be voided with the urine or exuding drop by drop from the urethra after coitus has been completed. This is commonly due to stricture, which may be of such calibre as not to interfere with the function of micturition when the circulation of the parts is in its ordinary condition, but which so encroaches upon the urethral calibre as the result of congestion incident to erection that the passage is practically obliterated. Another form of malemission is the condition in which the semen is not properly ejaculated into the vagina because of some defect in the urethra, such as hypospadia, epispadia, or urethral fistula. Such a patient is neither sterile nor impotent, yet he may be incapable of impregnation.

Oligospermia, or a diminution in the quantity of semen ejaculated, may indicate deficiency in total quantity or absence of any of the constituent parts of this fluid. Oligospermia may be due to general weakness, debilitating disease, sexual neurasthenia, sexual excesses, masturbation, or any of the various inflammatory or infiltrating affections which obliterate the ducts of the glands the secretion of which goes to make up the semen.

Oligozoöspermia indicates a condition in which the semen ejaculated contains a few spermatozoa. As a transitory condition it may be observed in healthy men.

Azoöspermia, or absence of spermatozoa in the semen, may be due to absence of both testes, to failure of the testes to produce spermatozoa, or to mechanical obstruction in some portion of the passage by which spermatozoa reach the urethra, though the testicles may fail to secrete spermatozoa when there is bilateral retention, atrophy, or malignant, syphilitic, or tuberculous degeneration. Congenital absence of the vasa has such effect. Even unilateral affections of the testicles cause azoöspermia. Prolonged exposure of the scrotum to the X-ray produces oligonecrospermia or true azoöspermia.

The ordinary cause is bilateral gonorrhœal epididymitis. This is followed by azoöspermia in a small percentage of cases, though not in the majority of those carefully treated; the obstruction is usually placed in the tail of the epididymis, but healthy spermatozoa continue to be formed in the testis, this gland departing from type in that obliteration of its excretory duct has no effect upon its function. Sexual excess produces temporary azoöspermia.

It is to be remembered that the semen discharged by those suffering from azoöspermia may be normal in odor, consistence, and primary gelatinification. On standing the white deposit is thinner; on microscopic examination the absence of spermatozoa is at once detected. This semen deposits the spermatic (Böttcher) crystals very rapidly.

Alterations in the color of the semen have been occasionally observed. It may be red from admixture with blood due to inflammation or intense congestion of the vesicles, vasa, or prostatic urethra. Unless the bleeding has been recent, the color will be a dirty chocolate. A large quantity of pus mixed with the semen may give it a yellowish or greenish tint. Indigo is sometimes found as a coloring matter, and is said to impart a reddish color to the fluid much like that due to admixture with blood.

Treatment.—Sterility dependent upon absence or imperfect development of any portion of the secreting or excreting apparatus is incurable. When due to gonorrhœal epididymitis of comparatively recent origin it usually proves amenable to the treatment described under the head of gonorrhœal epididymitis. When the obstruction persists, we have succeeded in relieving it by performing an anastomosis between the vas and that portion of the epididymis to the testicular side of the obstruction. The vas lies behind the spermatic artery, which sends its main branches forward to the inner side of the epididymis, anastomosing freely at this point with the artery of the vas. The epididymis is approached from its outer side. A portion of the head is picked up in toothed forceps and excised. If this excision is made on the testicular side of the obstruction there will ooze from the wound, semen which contains motile spermatozoa. The

lumen of the vas is opened by a longitudinal cut one-quarter of an inch long. Into this wound of the epididymis the vas is implanted by means of four fine silver-wire sutures, carried on small face needles from the outer surface of the vas into its lumen; thence from the cut surface of the opening made into the epididymis through its fibrous tunic (Fig. 236). Because of the smallness of the structures involved, the operation is tedious rather than difficult. Aside from the ordinary surgical instruments, there will be needed a sharp-pointed pair

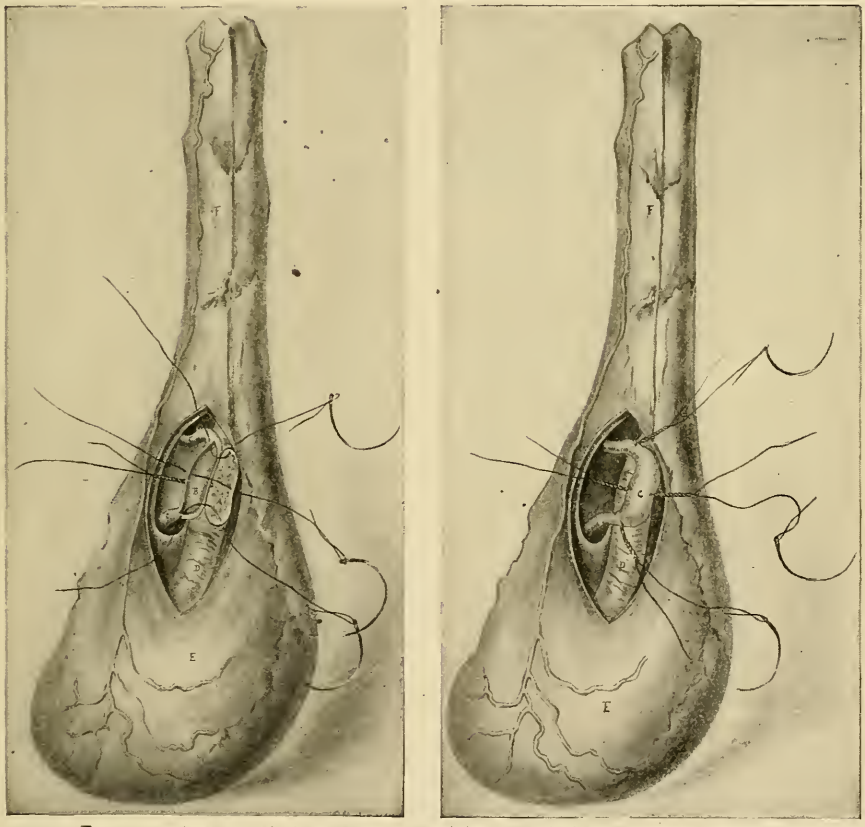


FIG. 236.—Anastomosis between the vas deferens and the head of the epididymis. A, opened tubules of epididymis; B, mucosa of vas; C, vas sutured to epididymis; D, head of epididymis; E, tunica vaginalis testis; F, cord.

of scissors, a slender bistoury, and a grooved director, such as are used by ophthalmologists.

Before performing this operation chronic posterior urethritis, vasitis, and vesiculitis must be cured. During the course of the treatment indicated, particularly if it be supplemented by massage of the epididymis, with counter-irritation and the wearing of a suspensory bandage, the spermatozoa will sometimes reappear in the emissions. The patency of the ejaculatory ducts may be determined by injecting at the time of operation watery suspensions of

indulin and carmine into the lumen of each vas as it is opened, noting upon which side each has been used. At the conclusion of the operation vesicular stripping will usually express from the urethra some of the coloring matter, or the first urination will exhibit it; the first subsequent emission will surely show it if there be no obstruction beyond the point of anastomosis. The operation will render fertile about fifty per cent. of those upon whom it is performed, provided there be no obstruction beyond the site of anastomosis. When the sterility is dependent upon blocking of the common ejaculatory duct, no treatment has been suggested which promises favorable results.

Sterility dependent upon stricture is cured by full dilatation of the urethra. If due to muscular incoördination, tonic or stimulant treatment directed to the general nervous condition may be beneficial. That form of sterility which is apparently dependent upon chronic suppuration of the prostatic urethra, ejaculatory ducts, seminal vesicles, and ampullæ of the vasa is best treated by massage, combined with unirritating antiseptic urethral irrigations.

CHAPTER XX

PSYCHOPATHIA SEXUALIS

The various forms of perversion or aberration of the sexual instinct are, as a rule, associated with symptoms which belong to the domain of the neurologist or the alienist. But some of them have a physical basis which demands attention from the genito-urinary specialist, who is, at any rate, apt to be first consulted in many such cases. Moreover, the distinction between a pure neurosis and one dependent upon lesions often requires the judgment of an expert, based upon a thorough examination of the genital tract. It seems proper, therefore, to present a brief summary of the chief varieties, and to give at least a *résumé* of the general principles which should apply in dealing with these patients. The works of Krafft-Ebing and Schrenck-Notzing have been used freely in the preparation of this chapter.

An accurate and entirely scientific classification of these phenomena is at present impossible, but a provisional one may be employed, which will aid in the systematic study of the subject.

Nearly all the known varieties of sexual perversion will fall under one or other of the following headings:

A. Sexual Hyperæsthesia.
   1. Onanism.
   2. { Satyriasis. / Nymphomania.

B. Sexual Anæsthesia.
   Impotence. (See Chapter XIX.)

C. Sexual Paræsthesia.
   1. Heterosexual perversion—algolagnia. Perverse activity of the sexual impulse.
   2. Inversion of the sexual feeling (contrary sexual feeling; homosexuality, etc.).

SEXUAL HYPERÆSTHESIA

When not dependent on affections of the cord or on cerebral disease, this is usually associated with hyperæsthesia of the deep urethra. This in its turn may be caused by masturbation when practised in great excess, by urethral stricture, by chronic infection, by sexual intemperance (which term should include both excessive intercourse and prolonged sexual excitement without relief, and by departure from the normal or physiological in the performance of the act of copulation (as, for example, the practice of withdrawal for the prevention of conception). Certain drugs produce it, cantharides being the best known.

Onanism is the common expression of sexual hyperæsthesia, a majority of males having at some time in their lives practised it. Its alleged consequences are used by quacks to foster the miseries of the sexual hypochondriac, who,

having almost always been a masturbator to some extent during his youth, is easily led to believe that he has thus done himself serious injury. Von Schrenck-Notzing, in reply to the argument that the single act of masturbation is no more harmful than that of normal coitus, says that masturbation has a much more intense psychical effect than sexual intercourse, as the content of ideas in every onanistic act must overcome reality, and thus a much more intense strain of the imagination is necessary. He adds, however, that " masturbation moderately practised exercises on a good constitution no direct destroying effect, but it changes, when it is long indulged in, the character, the imagination, and the whole mental existence in a way that is unmistakable and, so to speak, necessary. These evil effects of onanism seem to us to be greater than those lesser disturbances which seldom affect materially the general health."

A long list of local disorders following excesses in onanism is to be found in the abundant literature of the subject. Löwenfeld (quoted by Schrenck-Notzing) says that in the male the most frequent results are " excessive pollutions (day and night), spermatorrhœa, premature ejaculation in attempt at coitus, hyperæsthesia of the genital centres, spinal neurasthenia, congestion of the prostate, inflammation of the urethra, hyperæmia and swelling of the mucous membranes, and intense sensitiveness of the glans. In young children, besides, there may readily occur vesical tenesmus, wetting of the bed, spasm of the compressor urethræ, and urinary incontinence." Further results are urethritis, prostatorrhœa, spermatorrhœa, and impotence. As secondary results of the neurosis of the lumbar portion of the cord he mentions " general neurasthenia, tachycardia, pains in the eyelids, spasm of the lids, photophobia, or subjective sensations of light, diminution of the acuity of central vision, neurasthenic asthenopia."

In the female masturbation is said to produce neurasthenic disturbances, such as hysterical attacks, paralyses (vesical paralysis), vesical tenesmus and spasm, ovarian neuralgia, weakness of the legs, and spinal irritation. Among alleged local disturbances may be mentioned hyperæmia of the labia minora and the vaginal orifice, desquamation of the vaginal epithelium, cervical catarrh, intense hyperæsthesia, pruritus vulvæ, hypertrophy of the clitoris, and irritable conditions of the uterus and adnexa. Schrenck-Notzing says that " a condition that has thus far been too little studied, and which in its significance is one of the most important and frequent results of masturbation in the female, is a form of impotence in which the orgasm no longer occurs during the sexual act, even when it is performed with several men, but in many cases may be induced *post coitum* by masturbation."

In both sexes the act of masturbation, while unquestionably exercising a prejudicial influence on the general character on account of the sense of wrongdoing almost invariably accompanying it and the atmosphere of secrecy and deceit which necessarily surrounds it, cannot in normal individuals be accredited with more than a very small proportion of the evils said to follow in its wake.

In neuropathic children of adolescents, the inheritors of depraved nervous systems or of vicious impulses, it is no doubt far more injurious, but even in them it is open to question whether it is a cause or a symptom of the associated nervous phenomena. An investigation made by one of the writers showed that

the men who had become onanists in a criminal population of eight hundred were classified either as the subjects of mental or physical disease at the time of their admission to prison or as hereditarily predisposed to such disease in the proportion of eighty-five per cent. Among the remainder of the eight hundred only fifty-eight per cent. were so classified. So, too, it was found that fifty-six per cent. of the masturbators had been guilty of one or another of the so-called "crimes of the passions"—as distinguished from crimes against property—while a review of the records for fifty years showed that only thirteen per cent. of the whole number of convicts had been convicted of crimes of this character. The evidence, therefore, goes to show that masturbation in great excess is itself a symptom rather than a cause of the various nervous phenomena attributed to it.

As to the ordinary form of masturbation, so common as almost to be called physiological, Sir James Paget said twenty-five years ago "you may teach positively that masturbation does neither more nor less harm than sexual intercourse practised with the same frequency with the same conditions of general health and age and circumstance. Practised frequently by the very young—that is, at any time before or at the beginning of puberty—masturbation is very likely to produce exhaustion, effeminacy, over-sensitiveness, and nervousness, just as equally frequent copulation at the same age would probably produce them. Or, practised every day, or many times in one day, at any age, either masturbation or copulation is likely to produce similar mischiefs or greater. And the mischiefs are especially likely or nearly sure to happen, and to be greatest, if the excesses are practised by those who, by inheritance or circumstances, are liable to any nervous disease, to 'spinal irritation,' epilepsy, insanity, or any other neurosis. But the mischiefs are due to the quantity, not to the method, of the excesses; and the quantity is to be estimated in relation to age and the power of the nervous system." He has seen as numerous and as great evils consequent on excessive sexual intercourse as to excessive masturbation; but he has not seen or heard anything to make him believe that occasional masturbation has any other effects on one who practises it than has occasional sexual intercourse, or anything justifying the dread with which sexual hypochondriacs regard having occasionally practised it.

Treatment of Onanism in Children.—In the absence of inherited neuropathy, onanism in very young children is usually an automatic act, resulting from some persistent local irritation.

Phimosis, balanitis, vesical calculus, and urethral polyp are common causes of sexual excitation in male children, producing the custom of handling or pulling at the penis, which after a time results in a fully formed onanistic habit.

Masturbation in young female children is far less common than in males. Eczema and pruritus vulvæ, seat-worms, and other causes of irritation about the genitals or the anus are the common etiological factors.

In both sexes irritation from diapers or from tightly fitting clothing may favor the continuance of the habit.

Obviously the treatment of such cases is to be directed towards the removal of the cause. Circumcision should be performed, regardless of the condition of the foreskin, in all children who have this habit.

Even if it is not very long or tightly adherent, its removal lessens the sensitiveness of the glans and the frænum. The psychical effect of the operation itself, if the child is three or four years of age or older, has a powerful deterrent influence. Vesical calculi should be removed, eczema cured, and the other pathological conditions mentioned should receive appropriate treatment.

Intelligent parents can be of great assistance in breaking up the habit. The individual management of the child must be determined by his peculiarities of disposition and temperament. With some children, even while they are very young, a few words of caution or advice are effectual. With others some form of punishment is required. Occasionally it may be necessary to apply a vesicant to the genitals, thus leaving a denuded spot which will be painful enough to prevent handling of the part.

Attention should be paid to the condition of the urine. An excess of uric acid, oxaluria, a very acid or concentrated urine, may furnish the necessary stimulus to the performance of the act.

The diet, especially the evening meal, should be light and simple. Constipation should be carefully avoided. An enema of cold water at bedtime, followed by the insertion of a white wheat gluten suppository into the rectum, will often be found of advantage.

Open-air exercise to the point of fatigue is indicated in the majority of cases. Drugs should be avoided. Hand-guards and constant supervision are needed in some instances.

Treatment of Onanism in Adolescents and Adults.—In all cases of persistent masturbation, at whatever age, the same general line of treatment as that outlined above should be followed. The conditions that are provocative of the act in young children may cause its continuance after puberty. In males circumcision is especially to be recommended, the patient being told that the operation is necessitated by his previous indulgence in the vice, and that it will prove curative. Cold bathing, a simple natural life, a plain diet, plenty of exercise, and avoidance of sexual excitements, are the main points to be observed as to the hygiene of such patients.

The use of full-sized cold steel sounds introduced twice weekly, and left in the urethra for from ten to fifteen minutes, instillations of fifteen to twenty drops of a one per cent. silver nitrate solution into the prostatic urethra, and counter-irritation to the perineum, are at times serviceable therapeutic measures.

As to the general advice to be given such patients in regard to their sexual relations, while we agree with those who think it improper to advise fornication, and believe it is inadvisable to recommend marriage as a mode of treatment, yet we must dissent from the opinions which have been expressed by many of the most distinguished men in the profession as to the universal harmlessness of enforced chastity. Sexual abstinence, when entirely voluntary and spontaneous, and practised without thought or mental struggle on the part of the patient, is doubtless harmless. But it seems so equally beyond doubt that the continence which is the result of fear of wrong-doing or of dread of social disgrace or of physical disease, and which is attended with continued sexual excitation and constant hyperæmia of the genital organs, is ultimately harmful. It does not follow that a remedy can be suggested. Moreover, the evils which

certainly result from continence in individual cases are far less than those which would result from promulgation of the doctrine that " the idea of complete health includes complete and regular satisfaction of all the needs of man, and that is the goal for which hygiene must strive, and not seek to stifle one of the most important functions of the organism, like the sexual instinct. The recommendation voluntarily to destroy any function like the idea of love is a subject for the fanatic, but directly opposed to hygiene." (Tarnowsky.)

Von Schrenck-Notzing, writing of prostitution, says, " The limitation of the evil to a minimum, which seems to everyone of any knowledge of the subject both desirable and attainable, with any prospect of relative success, can only be brought about through an inner reform of society; through correct education of the young and ignorant; and through an increase of facility of marriage and amelioration of conditions of life. ' For the more undeveloped an individual is, the more reckless he is in the gratification of his desires.' We should institute a real sexual education, and lead the matured sexual instinct by means of the preservation of rational indulgence into paths devoid of danger; we should make needful concessions to the natural impulse; and thus public vice, with its results, the unlimited spread of venereal diseases and the increasing number of crimes against morality, would be greatly diminished and become more and more confined to the step-children of nature (those subject to congenital viciousness). But, more than all, the foundation would be removed upon which rest masturbation and the development of the sexual instinct in perverse directions."

Continuing, he adds, " The strength and intensity of the sexual instinct, like moral and physical individuality, are too various to make it necessary to give a general application to the foregoing statements. Such a misunderstanding might become a welcome license and cloak for all possible expression of vice, and it would open the door to sensuality. While one, thanks to the inherent peculiarities of his organization, can easily practise abstinence, another is led to onanism, and, as a result of it, is utterly ruined if he has no opportunity for natural sexual indulgence."

The patients " utterly ruined " by onanism are very few, but it must be admitted that even in the cases in which it is a symptom rather than a cause of disease normal sexual relations are greatly to be desired for the patient.

In the present constitution of society individuals must suffer. We cannot follow either in theory or in practice the further teaching of Notzing, who says, " The chaste youth should exercise sexual abstinence as long as he is able to restrain the instinct without injury to his health. Should he be in danger, owing to increasing strength of his sexual impulse, of onanism, of falling a victim to satyriasis or perverse sexual indulgence, then it becomes the duty of his teacher and his physician to cause indulgence in coitus, and also to acquaint the neophyte with precautionary measures which will guard against excesses, infection, and the procreation of illegitimate offspring, which, under certain circumstances—*e.g.*, with contrary sexuality—may be hereditarily tainted. Individual sexual capabilities should determine the frequency of sexual indulgence. It is impossible to fix a normal standard."

It is not customary in this country to give advice of this character, and

the resultant evils, if this should become a common professional practice, would far outweigh the advantages. The contrary teaching as to the invariable harmlessness and even benefit of sexual continence is unscientific, and is opposed to many easily observed clinical phenomena.

Satyriasis and Nymphomania.—In these cases the sexual desire is so overpowering that its gratification becomes the one dominant thought and purpose of the patient's life. The condition may be spasmodic with remissions, or, in bad cases, may be almost continuous. It is favored by any form of genital irritation, but the essential factor is some cerebral disturbance or degeneration which results in a diminution or abolition of the will-power. Magnan locates these lesions in the sensory regions of the cortex which lie behind the central convolutions, where, according to this author, " the zone of the desires and instincts lies, and which are influenced quasi-automatically by the genito-spinal centre as soon as the forebrain for any reason ceases to act."

It may in some cases be a reversion to ancestral instincts. In many of the lower animals during the rutting season the sexual impulse becomes so powerful as to dominate all other desires and habits and render the individual insensible to dangers ordinarily carefully avoided.

Women are said to be more subject to this form of sexual perversion than are men. Whether this is true or not, there can be no doubt that, since women have less sexual need than men, a predominating sexual desire in them should arouse more early a suspicion of its having some pathological significance.

Krafft-Ebing says that " the central origin of sexual excitement is of frequent occurrence in persons having a neurotic taint or hysteria, and in conditions of psychical exaltation. Here, where the cortex and the psycho-sexual centre are in a condition of hyperæsthesia (abnormal excitability of the imagination, increased ease of association), not only visual and tactile impressions, but also auditory and olfactory sensations, may be sufficient to call up lascivious concepts."

Magnan reports the case of a young woman who had an increasing sexual desire from puberty, and satisfied it by masturbation. Gradually she grew to become sexually excited at the sight of any man pleasing to her, and, since she was unable to control herself, she would sometimes shut herself up in a room until the storm had passed. At last she gave herself up to men of her choice, that she might get rest from her tormenting desire; but neither coitus nor masturbation brought relief, and she went to an asylum.

The case is added of a mother of five children, who, in despair about her inordinate sexual impulse, attempted suicide, and then sought an asylum. There her condition improved, but she never trusted herself to leave it.

It is obvious that in such patients the sexual symptoms are only part of a general disease, probably cerebral in almost every instance.

They are acute manifestations of a more or less chronic degenerative process, which later will nearly always show itself by some form of paresis or paralysis, or by mania or dementia.

Krafft-Ebing says, " There are also cases that, not without reason, might be called chronic satyriasis or nymphomania. To these belong the men who, for the most part as a result of abusus veneris, or more particularly of masturbation,

suffer with neurasthenia sexualis, and at the same time have intense libido sexualis. The imagination, as in acute cases, is in a state of excitement and the mind full of obscene images, so that the most elevated ideas are besmirched with the most cynical images and thoughts. The thought and desire of such men are solely directed to the sexual sphere; and since their flesh is weak, led on by their fancy, they come to indulge in the grossest perversions of the sexual act. Analogous cases in women may be called chronic nymphomania. They naturally lead to prostitution."

In all these cases the genito-urinary surgeon may be of use in removing every source of peripheral irritation, an important element of treatment, as it renders more easy a restoration of the balance between desire and will-power.

SEXUAL ANÆSTHESIA

In men the ordinary forms of impotence, or inability to perform the sexual act, are among the manifestations of sexual anæsthesia, and are described in Chapter XIX.

The corresponding forms of impotence in women are less frequent, so far as the profession has any reliable knowledge of the subject. The most common variety is said to be that in which failure of the female to secure orgasm during the sexual act is owing to premature ejaculation on the part of the male—premature, that is, in relation to the woman's requirements. This appears to be due in a large proportion of cases to a degree of sexual coldness which is not overcome by the ordinary mechanical excitation of the parts, and may result from either physical or psychical conditions.

Among the former is to be noted disproportion between the genital organs of the two individuals, as in cases of abnormally small development on the part of the male or of unusually large and relaxed genitalia on that of the female. Exhaustion of the sexual centre from long-continued uterine or ovarian irritation, neurasthenia, and vaginismus should also be mentioned. Emotional conditions are among the chief psychical causes of impotence in the female—the fear of pregnancy, or of disease, or of discovery, when the intercourse is illegitimate; the lack of affection, or of some of the sentimental concomitants of the act, when it is performed maritally.

It is obvious that in the management of these cases the tact and intimate personal knowledge of the regular medical attendant are likely to be of far more use than any surgical or gynæcological procedures, which must be limited to the removal of obvious sources of irritation and of any mechanical impediments to intercourse.

The foregoing conditions barely fall within the limits of sexual psychopathy, but there are more marked examples of sexual anæsthesia in both sexes in which the absence of sexual instinct seems to be absolute and to depend upon central causes.

Krafft-Ebing says that these functionally sexless individuals are seldom seen, and are, indeed, always persons having degenerative defects, and in whom other functional cerebral disturbances, states of psychical degeneration, and even anatomical signs of degeneration, are observed. With such patients there is

even less opportunity for treatment, which should in any event be directed by the neurologist or alienist.

SEXUAL PARÆSTHESIA

In all its forms this condition involves a perversion of the sexual ideas with relation to the individual. The perversion may be—1, heterosexual, with abnormal and distorted activity of the sexual impulse, or, 2, homosexual.

1. Algolagnia (*algos,* pain; *lagnos,* lust).—In the heterosexual varieties of the disease—*i.e.,* those in which an inclination to intercourse with the opposite sex exists—the perversion may take the form of associating acts of cruelty and violence with the act of coitus. When such acts are directed by the patient against another person the disease is known as *sadism* (active algolagnia). This is not infrequent, especially with males. It is explained on the theory that the two emotions of lust and anger both throw the psychomotor sphere into a state of extreme excitation, causing an impulse to react in every possible way on the object that supplies the stimulus. In neuropathic individuals this impulse becomes uncontrollable and leads to mutilation or murder. The disease is more frequent in males because to them belongs the aggressive *rôle* in sexual life, and their sexual relations have always involved the overcoming of obstacles. In the presence of pathological conditions this aggressiveness, usually physiological, becomes uncontrollable and leads to various monstrous and unnatural crimes.

The Whitechapel murderer is in all probability an example of the most extreme form of sadism. A minor form is illustrated by one of Tarnowsky's cases. The patient was a physician of neuropathic constitution reacting badly to alcohol. Under ordinary circumstances capable of normal coitus, as soon as he indulged in wine he found that his increased desire was no longer satisfied by simple coitus. In this condition he was compelled to prick the nates puellæ or to make stabs with the lancet, to see blood and feel the entrance of the blade into the living body, in order to have ejaculation and experience complete satiety of his lust.

Cases exemplifying a great variety of forms of sadism have been published in detail. They differ only in degree from those in which the abnormal impulse is satisfied by biting, scratching, or light flagellation to those in which the patient becomes a veritable monster, sucking the blood or eating the flesh of his victim.

Masochism (passive algolagnia) is the converse of sadism. The abnormality manifests itself in a desire to suffer and be subjected to violence and cruelty. It might be expected that for similar physiological reasons to those which explain the greater frequency of sadism in males, masochism would be found far more frequently in females, whose normal instincts lead towards sexual subjugation and submission. But except in very rare instances the restraints of custom and of modesty have been sufficient to prevent women from giving noticeable expression to this form of sexual perversion, which probably often constitutes an unobserved stage of mental disorder shown later in other ways.

" In masochism there is also a graduation of the acts from the most repulsive and monstrous to the silliest, in accordance with the degree of intensity of the perverse instinct, and the power of the remnants of moral and æsthetic motives

that oppose it. The ultimate consequences of masochism, however, are opposed by the instinct of self-preservation, and therefore murder and serious injury, which may be committed in sadistic excitement, have here, as far as known, no passive equivalent in reality; but the perverse desires of masochistic individuals may, in imagination, attain these extreme consequences." (Krafft-Ebing.)

Rousseau appears to have been a masochist, and, according to Lombroso, Baudelaire belonged in the same class.

2. Homosexuality, or contrary sexual instinct, is a form of sexual paræsthesia of unknown etiology characterized by the existence of sexual desires and instincts exactly opposite to those appropriate to the sex to which the patient belongs.

" In so-called contrary sexual instinct there are degrees of the phenomenon which quite correspond with the degrees of predisposition of the individuals. Thus, in the milder cases, there is simple hermaphroditism; in more pronounced cases, only homosexual feeling and instinct, but limited to the vita sexualis; in still more complete cases, the whole psychical personality, and even the bodily sensations, are transformed to correspond with the sexual perversion; and in the complete cases the physical form is correspondingly altered." (Krafft-Ebing.)

In accordance with this classification the same author describes the following varieties of the disease:

1. Psychical Hermaphroditism.—The characteristic mark of this degree of inversion of the sexual instinct is that, by the side of the pronounced sexual instinct and desire for the same sex, a desire towards the opposite sex is present; but the latter is much weaker and is manifested episodically only, while the homosexuality is primary, and in time and intensity forms the most striking feature of the vita sexualis.

It is thought that such individuals, on account of neurasthenia, of masturbation, or of unfavorable experiences in sexual intercourse with persons of the opposite sex (lack of pleasure, weakness of erection, premature ejaculation, infection, etc.), may have the homosexual instinct strengthened, and after satisfying the impulse by passive or mutual onanism with a person of the same sex, or by *coitus inter femora*, may pass into the second group.

2. Urnings.—In distinction from the preceding group of psychosexual hermaphrodites there are here, *ab origine*, sexual desires and inclinations for persons of the same sex exclusively; but, in contrast with the following group, the anomaly is limited to the vita sexualis, and does not more deeply and seriously affect the character and mental personality. (Krafft-Ebing.)

The patients belonging in this class have a disgust for coitus with persons of the opposite sex. Their affections are apt to be emotional and passionate; they present all the phases of sentimental attachment to persons of their own sex that are seen in normal individuals only between males and females. They are usually unable to have intercourse successfully in a normal manner, partly because the act of coitus is inhibited by their emotional condition. In men of this class mutual masturbation and often pederasty afford sexual gratification; in women, mutual masturbation in one form or another.

3. Effemination and Viraginity.—In this class not only the sexual in-

stincts but all the feelings and inclinations are reversed. The men are females in habits, sentiments, and character; the women, males. In such cases heterosexual love is looked upon as incomprehensible, and sexual intercourse with a person of the opposite sex as impossible. In homosexual intercourse the man always feels himself, in the act, as a woman; the woman, as a man. The means of indulgence, in the case of a man, where there is irritable weakness of the ejaculation centre, are simple *succubus,* or passive *coitus inter femora;* in other cases passive masturbation, or *ejaculatio viri dilecti in ore proprio.* Many have a desire for passive pederasty; occasionally a desire for active pederasty occurs. The sexual satisfaction of the female probably consists of *amor lesbicus,* or active masturbation.

4. Androgyny and Gynandry.—In this most extreme variety of homosexuality not only are the character and the feelings sexually reversed, but also the form, the features, and the voice, so that the individual approaches the opposite sex anthropologically and in more than a psychical and psychosexual way. This anthropological form of the cerebral anomaly apparently represents a very high degree of degeneration; but that this variation is entirely different from the teratological manifestation of hermaphroditism, in an anatomical sense, is clearly shown by the fact that thus far in the domain of contrary sexuality no transitions to hermaphroditic malformation of the genitals have been observed. The genitals of these persons always prove to be fully differentiated sexually, though not infrequently there are present anatomical signs of degeneration (epispadiasis, etc.), in the sense of arrests of development in organs that are otherwise well differentiated. (Krafft-Ebing.)

The works so freely quoted in the above outline of sexual psychopathy contain many suggestions as to therapy. The most important of these relate to the prophylaxis of such troubles by early recognition of the neuropathic constitution, the prevention of onanism, and the encouragement of normal or heterosexual impulses even in early youth by regulating the sports and the companions of children. Hypnotic suggestion is being extensively tried in adult cases, occasionally with excellent results.

CHAPTER XXI

SURGERY OF THE BLADDER

ANATOMY

The bladder, when normally distended, holds about one pint of fluid. Provided its walls are healthy, the urine may be retained without risk of injury till twice that quantity has accumulated. When from chronic obstruction there is constant, slowly increasing intravesical tension, the bladder may become greatly distended, retaining over a gallon of urine. When empty, or moderately distended, the bladder lies within the pelvis, between the posterior surface of the pubes and the rectum. As it fills, its upper portion rises from the pelvis and can be felt on abdominal palpation, since it tilts forward and is closely applied to the belly-wall. As tension increases, the upper posterior wall bulges upward, and may be felt even above the umbilicus.

The bladder is spoken of as consisting of three portions, the apex, the body, and the fundus, or base. Of these the apex is that portion in the region of the attachment of the urachus, or ligamentum umbilicale medium; the fundus or base lies below a plane passing through the points of entrance of the ureters into the bladder wall and the urethral orifice; while the body of the bladder is that portion between these regions. The vesical orifice, the lowest portion of the bladder in the erect position, is placed about one and a quarter inches behind and slightly below the middle of the pubic symphysis; in children, this orifice is on a level with the upper border of the symphysis, the bladder in them lying much higher in the abdomen.

The upper portion of the bladder is freely movable; its base is more or less fixed. It is held in place by the recto-vesical fascia, by the intimate muscular and fibrous attachments to the prostate, by the urachus and the obliterated hypogastric arteries, by its vascular connections, and finally by ligaments derived mainly from the reflections of the pelvic fascia (true ligaments) and from the peritoneum (false ligaments).

The urachus, a fibro-muscular cord, and the obliterated hypogastric arteries pass from the summit of the bladder to the umbilicus. The expansions of the pelvic fascia hold the neck and base of the bladder in position. The anterior or pubo-prostatic ligaments from either side of the lower portion of the pubic symphysis fix the prostate gland and the anterior part of the bladder neck; the lateral ligaments embrace the prostate and the lateral border of the bladder base. The false ligaments or peritoneal folds are the superior, covering the urachus and the obliterated hypogastric arteries from the umbilicus to the vesical apex, the lateral, reflected from the iliac fossæ to the bladder sides, and the posterior, containing the ureters and hypogastric arteries and bounding the recto-vesical fold.

Peritoneal Covering of the Bladder.—The peritoneal covering of the urachus and the obliterated hypogastric arteries passes directly to the bladder,

investing its posterior surfaces from the apex to the superior extremities of the seminal vesicles and the vesical extremities of the ureters. It is continued laterally to the position of the obliterated hypogastric arteries, passing backward as it descends to the recto-vesical cul-de-sac, and covering a portion of the vas deferens. Posteriorly, the peritoneum is reflected from the bladder to the rectum, forming the recto-vesical pouch. This pouch is usually more than three and less than four inches from the anus; exceptionally, the vesical peritoneum may descend as far as the prostate, and would then be less than two inches from the anal orifice.

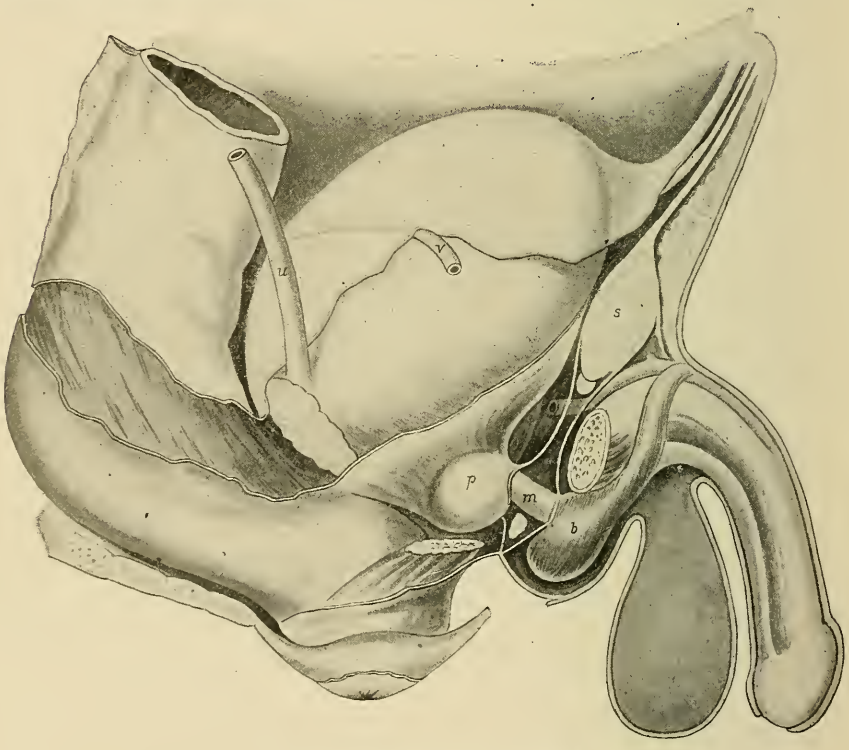


FIG. 237.—Side view of pelvic viscera.

When the bladder is empty the peritoneum lining the anterior belly-wall descends as far as the upper border of the pubis, and is reflected from this level to the vesical apex. As the bladder becomes distended this peritoneal reflection is lifted upward, and the anterior vesical wall becomes accessible to operation by suprapubic incision without danger of entering the peritoneal cavity (Fig. 237). When the bladder is moderately distended and is further elevated by rectal distention, the peritoneal reflection may be raised two inches above the upper border of the symphysis.

Exceptionally the parietal peritoneum is adherent to the symphysis. In this case a suprapubic cut must necessarily open the general abdominal cavity. There is no means of determining the presence of such an anomalous condition

before operation: hence the danger always possible in suprapubic puncture or aspiration.

Structure of the Bladder.—The mucous membrane of the bladder is made up of flat epithelium based upon deep layers of cylindrical cells. It is of a pinkish yellow color, exhibiting plications which disappear on distention of this viscus. In the trigonum the mucous membrane is applied directly to the subjacent structure, and slight papillary outgrowths are sometimes seen; exceptionally rudimentary glands are found. From embryological and histological standpoints, and in accordance with the symptomatology of lesions of this region, the trigonum is to be regarded as a part of the urethra rather than of the bladder.

The muscular walls of the bladder are arranged in three layers. The outer longitudinal layer contributes fibres to the formation of the anterior vesical ligaments. Through or between these musculo-tendinous fasciculi pass the anterior vesical veins to join the plexus of Santorini. The middle layer is composed of circular fibres completely covering in the bladder. These are thickest about the urethral orifice, forming the internal vesical sphincter. The inner layer is made up of longitudinal fibres passing from the apex to the neck. The fibres composing this layer are grouped in bundles or fasciculi, which anastomose, forming a coarse network and producing the characteristic reticulation of the inner surface.

Vascularization and Innervation.—Blood is carried to the bladder by branches of the internal iliac arteries. These are the superior vesical, supplying the apex and the lateral surfaces and deferent canals; the middle vesical supplying the base of the bladder and the seminal vesicles; the inferior vesicals, often from the middle hemorrhoidal, running to the prostate, the seminal vesicles, and the trigonum; and the anterior vesicals, small and variable, derived from the internal iliac or the obturator. These blood-vessels penetrate the muscular coats of the bladder, forming a submucous plexus from which the epithelial capillaries are given off.

The veins of the mucous membrane, having penetrated the muscular coat, form a superficial plexus, made up of large, freely anastomosing, valved trunks, usually running longitudinally. The anterior vesical veins pass into the pubo-prostatic plexus (plexus of Santorini), situated just beneath the symphysis to the right and left of the median line; the lateral veins, particularly voluminous and numerous, empty into the vesico-prostatic plexus. The posterior veins, also large, pass into the vesico-prostatic plexus or seminal plexus. The pubo-prostatic, the vesico-prostatic, and the seminal plexus anastomose freely, and practically form one series of large vessels, which is emptied by all the veins lying near at hand, including the hypogastric, the ureteric, the hemorrhoidal, the internal pudic, the obturator, and the spermatic.

The lymphatics of the upper two-thirds and lower anterior third and neck of the bladder drain into the external iliac ganglia, those of the posterior third into the hypogastric or presacral nodes.

The nerves of the bladder are derived from the hypogastric plexus and from the anterior branches of the third and fourth sacral nerves.

General Considerations.—At the bladder base lies the trigonum, presenting a smooth red surface, in the form of a nearly equilateral triangle, each

side of which is about one and a quarter inches long. The angles correspond in position to the internal vesical orifice and the two slight projections or openings of the ureters. The triangle may be distinctly outlined by perceptible ridges passing between the two ureteral openings and from these to the internal vesical orifice. These ridges represent a reinforcement of the vesical and ureteral muscles, designed to preserve the valve-like action of the ureters and to keep them closed against back pressure from the bladder.

The trigonum and the vesical neck are more abundantly supplied with blood-vessels and nerves than are any other portions of the bladder.

It follows from the position of the bladder that it is well protected from direct traumatism, and that it is accessible to exploration by combined rectal and suprapubic palpation. Its abundant blood-supply assures quick healing of surgical or accidental wounds when other conditions favorable for healing are present. The superficial layers of flat epithelium with which the mucous membrane is provided insure against absorption from the bladder as long as the epithelium remains healthy and unbroken, thus protecting the system against poisoning by toxic substances eliminated with the urine and guarding the tissues locally against infection. The loose attachment of the mucous membrane to the underlying muscular tissues and the arrangement of the muscular coat prevent extravasation of urine after puncture of a full bladder, the opening, on withdrawal of the needle or trocar, becoming valvular by the sliding of the tissues. The great venous plexus at the base of the bladder and the many large veins passing over its surface, together with the free intercommunication between all the pelvic veins, explain the frequency of dangerous venous bleeding in bladder surgery. These facts also show how important an effect upon the bladder is exerted by any cause, such as constipation, producing pelvic engorgement. The particularly generous innervation and vascularization of the trigonum and the bladder-neck explain the greater pain and reaction from inflammation or manipulation of this part of the viscus.

MALFORMATIONS AND MALPOSITION OF THE BLADDER

The bladder may be multiple. Its walls may be absent in whole or in part, may be hypertrophied, atrophied, or herniated. The urachus may remain patulous.

Multiple bladder, in the true sense of the term, is an extremely rare deformity. Usually there is a single bladder with a septum running fore and aft (Fig. 238) or obliquely or even transversely. The ureters open into the main bladder cavity. More frequently it is a sacculated bladder. Sometimes the apparent anomaly is due to the enormous dilatation of a ureter.

When the bladder is really multiple, as, for instance, in a reported case in which there were five kidneys, each with a separate receiving viscus, no operative measure is indicated. Sacculation, with attendant cystitis from defect of drainage, would indicate simply the treatment of the cystitis. Enormous dilatation of the ureter, if it could be diagnosed, would indicate the relief of the stricture or the formation of a new opening between the dilated ureter and the bladder.

Complete Absence of the Bladder.—When the bladder is completely absent, the ureters open into the urethra, the vagina, the rectum, or at the

umbilicus. The condition may be treated by the application of a urinal, which prevents the garments from being soiled, or by implantation of the ureters into the bowel, preserving a rosette of the tissue into which the ureter opens.

Exstrophy

Exstrophy of the bladder is usually observed as an absence of the anterior wall (Fig. 239), though cases are reported in which the septum separating the bladder from the vagina or the rectum has been absent. It is commonest in male children, and is due to the failure of the lateral portions of the uro-genital

Fig. 238.—Multiple fused bladder. The two bladders communicate by a small opening denoted by the probe. (From the Mutter Museum, College of Physicians.)

cleft to unite. Hence in pronounced cases there is a deficiency not only in the anterior wall of the bladder but also in the musculo-cutaneous abdominal parietes and the pelvic girdle, the pubes not meeting in the middle line to form the symphysis, the gap sometimes measuring as much as two inches. This deformity is associated with epispadia in the male and split clitoris in the female, the bladder and urethra opening in the female either into the vagina or just above it.

From weakness of the abdominal parietes there is commonly associated with this deformity complete double inguinal hernia, which, descending into the

cleft scrotum, causes its two halves closely to resemble the labia majora of the female. The prostate is rudimentary, the testicles often are ectopic. The seminal vesicles are either absent or are greatly atrophied. The ureters are often dilated, and sometimes so sharply bent that conseqeunt obstruction and dilatation occur. In the female the greater and lesser vulvar lips are not joined anteriorly, and the clitoris is split, the vagina being converted into a small channel. The recti muscles pass upward and inward on either side from their insertion into the separated pubis. Sometimes this separation is continued upward almost to the origin of the muscles, allowing the formation of ventral hernia.

On examining a case of exstrophy of the bladder there is found presenting

FIG. 239.—Exstrophy of the bladder. (From Mutter Museum, College of Physicians of Philadelphia.)

in the hypogastric and pubic region a bulging, moist, dark red surface of intensely inflamed rugous mucous membrane, surrounded by an area of cicatricial tissue, uniting its borders to the skin. This projection varies in size from that of a half walnut in infants to that of a man's fist in adults. It bleeds readily, is extremely sensitive, its lower portion is wet, and the projections marking the ureteral orifices can usually be found by the escape of urine, which spirts from them in jets. This tumefaction may extend upward as far as the umbilicus.

Continuous with the lower border of the mucous surface is the urethra, passing as a furrow on the dorsal aspect of the rudimentary penis, the prepuce of which forms a large flap hanging from the under surface of the glans.

Patients exhibiting this deformity are usually of poor physical development in other respects, and often perish from ascending pyelonephritis. As a result

of the leakage of urine inseparable from exstrophy, the surrounding skin becomes infiltrated and excoriated, and erysipelas sometimes develops. Sexual desire is generally wanting, though in the female this deformity does not necessarily interfere with coitus and parturition.

Associated deformities are by no means uncommon. At times the intestine or the anus opens through the exstrophied mucous membrane. Generally the anus is placed farther forward than normal. Spina bifida and club-foot may be associated with exstrophy.

In degree exstrophy varies from the slight form characterized by epispadia and a cicatricial condition of the skin in the neighborhood of the pubis, to the form characterized by complete hypogastric fissure with eventration. Between these extreme degrees of exstrophy there is every gradation. Heredity exerts no influence in causing this deformity.

The diagnosis of exstrophy is unmistakable. The scar-tissue surrounding the mucous membrane is congenital, and is not due to previous destructive inflammation.

The prognosis must be guarded, since the conditions are favorable to kidney-infection.

Treatment may be either palliative or radical. Palliative treatment consists in the application of a urinal so constructed that a hollow rubber cup accurately fits the skin surface surrounding the cleft, and thus enables the urine to be drained off into a reservoir (Fig. 240).

Radical operation consists in closing the defect by plastic operations, or in diverting the ureters.

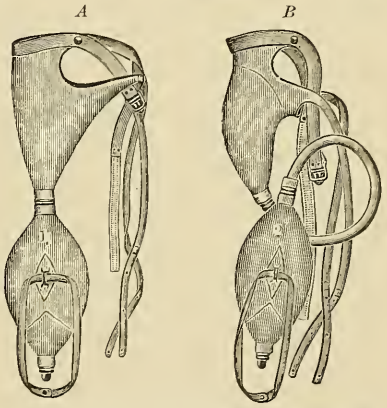


FIG. 240.—*A*, day urinal; 1, detachable reservoir. *B*, night and day urinal; 2, detachable reservoir.

The most successful radical operation can never make a satisfactorily retentive bladder, since a sphincter which will be under proper nervous control cannot be formed. Plastic operations usually aim to lessen deformity and to close the bladder sufficiently to allow of easy drainage by means of a urinal, thus protecting the surrounding skin from irritation and enabling the patient to keep himself clean. The Roux-Wood operation is the one most in favor. A cutaneous flap, the attachment of which corresponds to the upper border of the cleft, is turned down from above the bladder. This flap should be of sufficient length to cover entirely the exposed mucous membrane; the skin surface thus forms a new anterior wall for the bladder. The lateral borders of this flap are sutured with catgut to the freshened skin borders of the congenital cleft. There is thus formed a pouch, the anterior wall of skin, the posterior of mucous membrane. The raw outer surface of this first flap is then covered in by two lateral rectangular flaps which have their attached bases placed in the inguinal region of each side. These two flaps are made of such length that without undue tension they can be carried transversely across the raw surface of the first flap, covering it completely. The free borders of these flaps are sewed together with silkworm-gut.

Finally, the large wound resulting from the transplantation of these flaps is closed in as far as possible by means of silk sutures.

Closure of the bladder by direct suture possesses the advantage of forming a vesical cavity consisting entirely of mucous membrane. When there is bone-defect, an essential point in successfully performing this operation is the approximation of the two pubic bones. This may be accomplished in infants by subcutaneous symphyseotomy of the sacroiliac joints, followed by forcible lateral pressure and the application of a gravity apparatus.

Extraperitoneal implantation of the exstrophied bladder into the rectum has been successfully performed by Moynihan, the organ being freed except for the attachment of the ureters, inverted, and sutured into the anterior wall of the bowel.

Maydl has successfully accomplished this transplantation by opening the peritoneal cavity at the border of the exstrophied bladder and removing the whole of the latter except a small segment containing the ureteral orifices. Into the ureters are passed small catheters. The small bladder-segment left, together with the attached ureters, is thoroughly mobilized; the pelvic colon is drawn out and incised longitudinally, and in this opening is secured the portion of the bladder-wall containing the ureters. The mucous membrane is first sewed to the mucous membrane of the gut, then the musculo-peritoneal coating of the intestine is sutured to the muscular wall of the bladder-segment. Finally the abdominal wound is closed by suture. Orloff collected fifty-six cases of Maydl's operation. Eleven cases died within twenty-one days after operation; four from peritonitis. Of the forty-five remaining cases only five died of the later results of ascending infection. The post-operative complications have been pneumonia in six cases, fecal fistula in seven cases, phlebitis of the leg in one. Some renal colic and albuminuria were noted in nearly all. There is little irritation of the bowel and the anal sphincter remains competent.

Peters[1] describes in detail an excellent method of implanting the ureters into the rectum by the extraperitoneal route.

In certain appropriate cases the method of choice is direct suture of the freshened bladder-borders, thus forming an irregular cylinder, which acts not as a reservoir but as a conductor of urine, allowing a portable urinal to be employed. In children an effort should be made to close the bony defect by elastic or weight pressure. Symphyseotomy is by no means free from danger. The exact value of this procedure and the additional risk inseparable from it remain yet to be determined. When successful, it enables the surgeon to close the bladder and a part of the urethra by direct suture.

Ureteral deviation is theoretically the most satisfactory immediate treatment of exstrophy, but its mortality, both immediate and remote, is high.

Before any operation is performed the inflamed skin surrounding the bladder must be rendered healthy by cleansing washes and healing protective salves. Thus, twice daily the parts may be bathed in five per cent. ichthyol solution, followed by the application of a thick zinc paste, made by adding four drachms of finely powdered zinc oxide to an ounce of benzoated zinc ointment. This paste is removed by rubbing with cosmoline.

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[1] *Canadian Journal of Medicine and Surgery*, April, 1902.

Congenital diverticulum always causes hypertrophy of the bladder-wall, and ultimately is likely to exhibit the lesions of intense inflammation, and not infrequently of stone formation. The most pronounced symptom is frequent urination, which later, with the onset of inflammation, may be painful. There is commonly a sensation as though the bladder had not been completely evacuated, and after the act of micturition more urine can usually be voided. Occasionally attacks of retention occur. Diverticulum may form a distinct tumor which may be palpable either over the pubis or in the sacral concavity by rectal examination. Catheterization will draw off the urine in the bladder, and by pressure a further quantity can be evacuated, often exhibiting pus in considerable quantity. With the evacuation of this added quantity the tumor will disappear. Cystoscopic examination will show the opening into the diverticulum. At times lamps can be passed through the opening, or at least catheters can be introduced. The X-ray with collargol distention gives the clearest picture of the condition. Diverticular openings usually lie near the ureteral orifices.

Complicating cystitis exhibits a distinct predilection for middle-aged males. In the absence of cystitis diverticula are mainly symptomless.

The treatment of inflamed diverticula may be palliative, by irrigations and instillations through ureteral catheters, or radical, by extirpation. The operation is best performed through a long median suprapubic incision, following the technique of Squier for cystectomy (see p. 557).

Patent Urachus.—Occasionally, as a congenital defect, the communication between the bladder and the allantois is not entirely obliterated, and after birth urine escapes through the umbilicus. This condition is usually due to the back pressure incident to urethral obstruction.

Treatment consists in first rendering the urethra patulous. This in itself is often sufficient to produce a cure. If the fistula still persists, an occluding dressing, the application of the actual cautery, or excision of the sinus is indicated. Urinary concretions may form in these fistulæ. Occasionally suppurating urachal pouches which do not communicate with the bladder discharge pus through the umbilicus, or, if the umbilical opening becomes occluded, form prevesical tumors or abscesses. The treatment is complete excision of the suppurating sac.

Hypertrophy of the Bladder.—This term implies an overgrowth of the vesical muscles. Sometimes it is associated with marked thickening of the mucosa. It is always caused by increased functional activity incident to mechanical obstruction, to the escape of urine from the bladder, or to abnormally frequent micturition.

In cases of obstruction, particularly if it is at the vesical neck, there is usually coincident with hypertrophy a dilatation, often a partial sacculation, of the bladder, the weaker portions of the walls between the thickened muscular fasciculi yielding; this condition is known as eccentric, trabecular hypertrophy (Fig. 241). In vigorous young men, and this particularly represents the type suffering from chronic stricture, muscular hypertrophy may be universal, the resulting increased expulsive force of the bladder preventing retention and secondary dilatation. In older men, with enlarged prostates, the typically

dilated, thickened, trabeculated, and possibly sacculated bladder develops. Hypertrophy dependent upon frequent urination without obstruction, as in some cases of chronic posterior urethritis, is always concentric and lessens the size of the vesical cavity (Fig. 242). Cystitis is usually associated with hypertrophy, adding to the thickness of the bladder-walls.

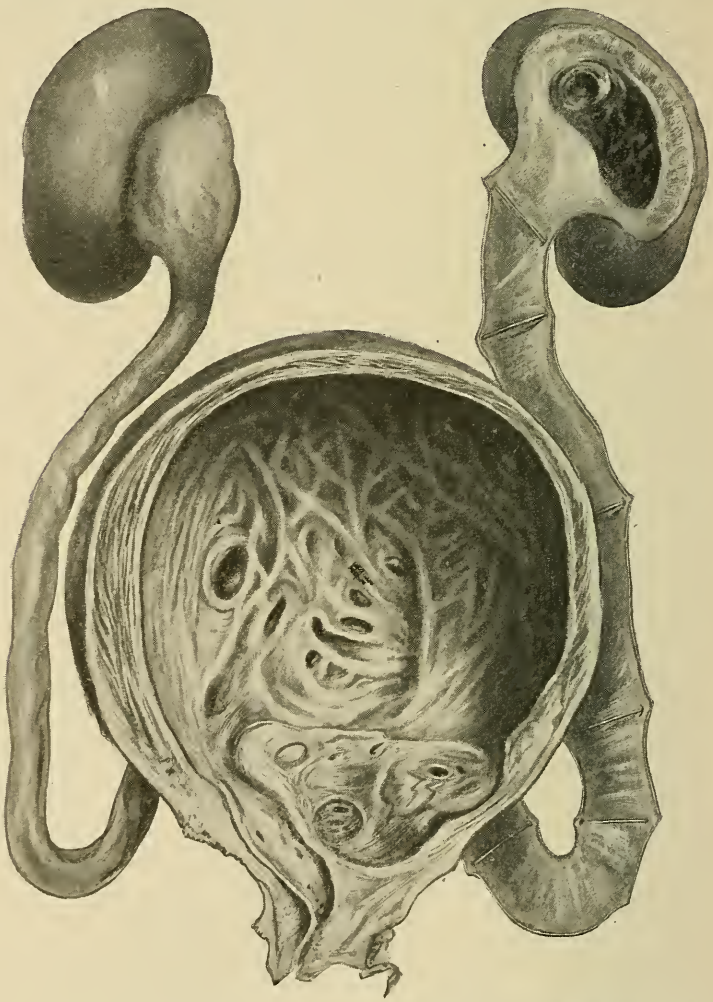


Fig. 241.—Excentric trabecular hypertrophy of the bladder. The vesical hypertrophy in this case is incident to urethral stricture. The trabeculae and diverticula are particularly well marked. Observe also the presence of hydro-ureters and hydronephroses. (From the Mutter Museum, College of Physicians of Philadelphia.)

The ultimate prognosis of hypertrophy is bad, since fibroid or fatty degeneration is liable to occur, with consequent diminution or entire loss of contractile power.

Diagnosis.—This, when the hypertrophy is associated with trabeculation

and dilatation, is made by the cystoscope. When there is concentric hypertrophy without dilatation, the lessened capacity of the bladder and the detection of its greatly thickened walls by bimanual rectal and suprapubic palpation, together with a preceding history of either frequent or difficult micturition, point to the true nature of the affection.

Treatment.—The direct treatment of the hypertrophy is unavailing. Relief of obstruction or of the necessity for frequent micturition will prove curative if this is accomplished before degenerative changes have begun.

Atrophy of the bladder may be caused by distention or by degeneration consequent on nerve-lesion. In old age there has been observed a fatty degeneration of both the detrusor and sphincter muscles. As a result of muscular atrophy the bladder loses the power of evacuating its contents and becomes a thin, sometimes enormously dilated pouch. If the sphincters, including the compressor urethræ muscle, are atrophied, there will result incontinence of urine; this symptom is usually associated with retention.

Fig. 242.—Concentric hypertrophy of the bladder.

Atony of the Bladder.—Weakness of the bladder muscularis, almost physiological in people past middle life, is usually due to overdistention, which may be acute and temporary as from lack of privacy for an urgently desired act of micturition, sudden urethral obstruction, or post-traumatic retention, or may be chronic and persistent as from gradually developed urethral obstruction or habitual deferring of the act of micturition. The hypertrophied bladder inevitably becomes atonic, as does the viscus which is subject to prolonged drainage. The atonic bladder may form a thin, enormous pouch, containing many pints of fluid (Fig. 243).

Diagnosis.—This is based on the history of an adequate cause, since except in the aged and in those subject to exhausting fevers atony is never primary. The stream of urine lacks in propulsive force even when a catheter is passed, unless the abdominal muscles are brought into play. There is always some residuum after urination, hence frequency of urination is usually noted.

Treatment.—After removal of the cause and the cure of the commonly accompanying cystitis, the atonic condition of the vesical muscles may be benefited by pituitrin hypodermically, strychnine, irrigations with hot normal salt solution, and the use of the slowly interrupted faradic current, one electrode being introduced into the bladder, which should contain not more than four ounces of fluid.

Hernia of the Bladder.—Under this term is included protrusion of a part

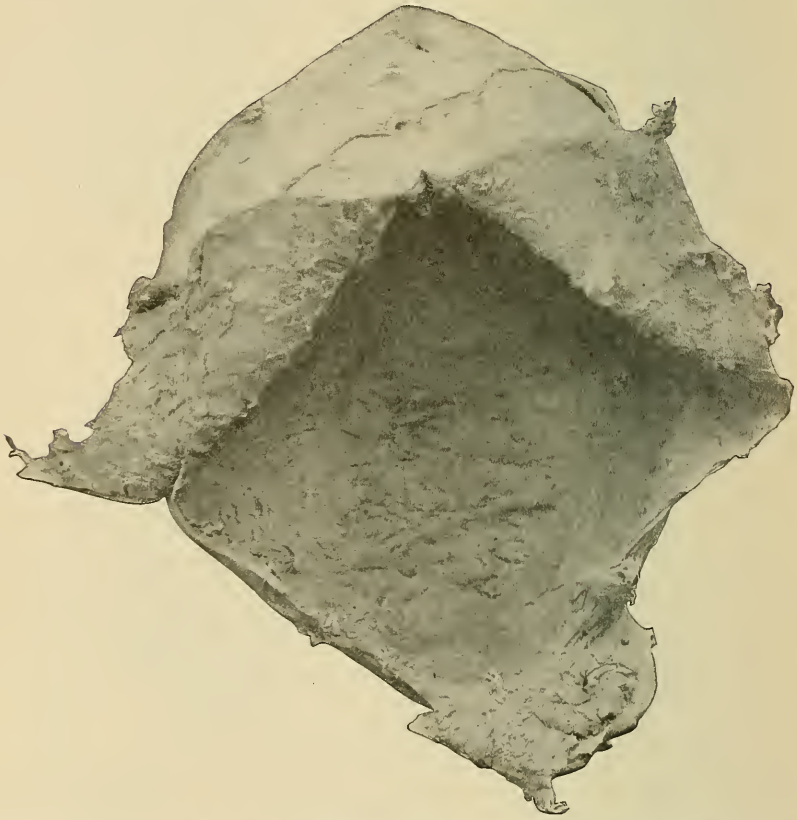


Fig. 243.—Atony of the bladder, with dilatation. (From a specimen in the Museum of the Philadelphia Hospital.)

of the bladder-wall along the track usually taken by intestinal hernia. Inguinal cystocele is the common form, though there are instances of obturator, crural, vaginal, and perineal vesical hernia.

Inguinal cystocele may appear in the form of a projection of the bladder without a true hernial sac—that is, without a peritoneal covering—the muscular coat of this viscus lying in immediate contact with the transversalis fascia and adhering to it. This is the usual form, and rarely attains large dimensions. Exceptionally there is partial or complete sacculation at the expense of the peritoneal investment of the bladder. Still more rarely the herniated

bladder forms a tumor entirely covered by its own peritoneum and invested in an additional true peritoneal sac. Either the summit or the lateral surface of the bladder is the portion found prolapsed. Even the most pronounced displacement is not sufficiently extensive to displace the ureters.

The herniated portion of the bladder usually presents thin walls, is often surrounded with considerable fat, and sometimes appears as a diverticulum with an extremely small opening into the general vesical cavity, the capacity of the latter not being particularly diminished. From stagnation of the urine in these diverticula calculi may form.

The causes of hernia of the bladder are overdistention and dilatation of this organ and a patulous condition of the hernial orifices. When the bladder is the first viscus to appear in the hernial region, its anterior surface, uncovered by peritoneum, descends, possibly dragged down by a preceding lipomatous formation. After this follows the part covered by peritoneum, forming an artificial sac, into which the gut may subsequently descend. The most frequent cause of bladder hernia is a preceding intestinal hernia, which, as it progresses and drags on the peritoneum in the formation of a sac, involves the bladder.

Symptoms.—The characteristic symptom of hernia of the bladder is the presence of a fluctuating tumor, dull on percussion and varying in size in accordance with the amount of urine contained in the bladder. This tumor may not grow smaller, even though the bladder be completely emptied, since it may communicate by a small orifice, which is closed when the patient is in the erect position. On lying down, however, and particularly after manipulation and gentle pressure which causes a desire to urinate, the somewhat tense fluctuating tumor becomes small and flaccid, and immediately a quantity of urine can be again evacuated. The flaccid, inconspicuous swelling becomes tense and full when injections are forced into the bladder. These symptoms are absolutely diagnostic. In addition, there are often symptoms of bladder irritation, such as frequent and difficult urination, retention, or evident cystitis. Exceptionally, when the herniated portion of the bladder is small, it offers no symptoms other than those associated with an irreducible omental hernia.

Vesical hernia is commonly complicated by enterocele or epiplocele. Usually this displacement is not suspected till, in the course of operation for intestinal hernia, escape of urine shows that the bladder has been opened. When there is more than the usual amount of fat projecting from the inner portion of the opening through which a direct inguinal hernia comes, the presence of the bladder should be suspected.

Treatment for this affection should be operative. A truss is not well borne, and reduction is impossible. The operation consists in carefully dissecting the bladder free of its adhesions, reducing it to its proper position, and permanently closing the hernial opening.

WOUNDS, CONTUSION, AND RUPTURE OF THE BLADDER

The bladder when empty is so deeply placed, so well protected by the bones of the pelvis, and, moreover, so movable, at least in its upper part, that it usually escapes the effects of even severe traumatism. When force has been applied sufficient to fracture the pelvic bones or to cause disjunction at the

pubic symphysis, even the empty bladder may be bruised, punctured or lacerated. Horns, weapons, or pointed stakes may wound this viscus when driven into the perineum or rectum, through the obturator or sciatic foramen, or above the pubis. Bullets may reach the bladder either through the outlets of the pelvis or directly through its bony substance. Rough instrumentation may cause laceration of the vesical walls. Finally, when the bladder is full or overdistended, force applied from without, even though insufficient to cause disjuncture of the pelvic bones or superficial bruising, may occasion either contusion or rupture of the bladder.

Wounds of the Bladder.—The term wound implies a solution of the continuity of the soft parts extending from the skin surface down to the bladder-lesion. Rupture and contusions will be separately considered. Nearly all wounds of the bladder can be classed as contused or lacerated, including under these headings gunshot wounds.

Incised wounds are usually inflicted by the surgeon, either intentionally, as in cystotomy, or accidentally, as in extirpation of pelvic tumors. In the latter case prompt closure of the wound by suture is nearly always followed by immediate union, the danger incident to this accident lying in the risk that it may be overlooked. When the wound does not entirely penetrate the visceral wall, involving, for instance, the serous and muscular coats only, the mucous coat remaining intact prevents extravasation, and cicatrization is unhindered.

Contused and lacerated wounds, the common variety, are usually inflicted by way of the perineum or the rectum, as the result of a fall upon a stake or a paling, or are due to wounding by firearms. They are also caused by inadvertence in surgical manipulations. Thus, Neumann in extracting a stone adherent to the vesical wall in a boy, aged nine, tore an opening through both bladder and rectum. In accordance with the portion of the bladder involved the wound is termed intraperitoneal or extraperitoneal. From the standpoint of prognosis this classification is important.

Symptoms.—The symptoms of wound of the bladder are—1, escape of urine through the wound; 2, frequent straining effort at urination, with the passage of blood or bloody urine; 3, the detection of an opening in the bladder by means of a probe passed through the wound, or of a sound passed through the urethra, aided by digital examination per rectum, or by a combination of these methods. Cystoscopic examination may be needful before formulating a diagnosis.

Hæmaturia may be the only symptom. Escape of urine through the wound can take place only when the tract of the latter is of some size and is fairly direct. In the case of a small wound, such as would be made by a twenty-two-calibre pistol-ball, the tract remains direct only so long as the bladder maintains the same degree of distention as at the moment of wounding. As the bladder contracts the opening through its walls no longer lies in the same line as the wound of the parietes. Moreover, contraction of the muscular layers makes the opening through their substance smaller, and the mucous membrane has a tendency to prolapse, and thus occlude the wound more or less completely. It is only when the wound is large and direct that this pathognomonic sign of bladder-rupture will be found.

Though tenesmus and the frequent voiding of a small quantity of blood or bloody urine are noted as a rule, these symptoms are not invariably excited. There may be absolute inability to pass anything from the bladder by the urethra. Introduction of a probe into the bladder through the wound is most difficult where this viscus has changed the relation of its wounded wall to the parietes, though when this manœuvre is successful, and when the probe can be made to strike a metal catheter carried through the urethra into the bladder, the diagnosis is, of course, certain.

Complications of Wounds of the Bladder.—Immediately following a wound of the bladder hemorrhage may prove a serious complication; this, when so violent as to threaten immediate death, comes from the large vascular trunks in the pelvis, and not from the bladder-wall.

In a few hours or days usually, but sometimes in cases of gunshot wounds not until after one or two weeks, septic peritonitis may develop from intraperitoneal wounds, or septic cellulitis from extraperitoneal wounds.

The remote complications are fistulæ, which may pass from the bladder to the vagina, to the rectum, or to the external skin surface, and concretions which may be formed around foreign bodies, such as shot, bullets, fragments of the garments, or splinters of bone.

Diagnosis.—When the typical symptoms are present the diagnosis is easily made. When these symptoms are mainly wanting and the presence of bloody urine and a wound of entrance passing in the direction of the bladder are the only signs suggestive of the lesion, examination of the vesical walls by means of a sound passed through the urethra, aided by digital exploration through the rectum, is indicated. If this is not conclusive in its results, the injection and immediate withdrawal of a measured quantity of dilute antiseptic solution may prove serviceable. (See Rupture of the Bladder.) If this does not clear the diagnosis, the cystoscope should be used, the bladder being first washed clear of blood by irrigation with a hot antiseptic solution. If there is too much blood in the bladder to allow of the use of the cystoscope, suprapubic or perineal cystotomy should be performed for the purpose of establishing the diagnosis, the choice of operation depending on the position of the external wound.

Prognosis.—This depends upon whether the wound is extraperitoneal or intraperitoneal. The intraperitoneal wounds are generally fatal from septic peritonitis, though recovery from extravasated urine becoming encysted and absorbed, or from closure of the bladder-wound by adherence of bowel or omentum to its peritoneal aspect, is possible.

The prognosis of extraperitoneal wounds is much more favorable; in the absence of lesions of other organs the large majority will recover. Large, clean, direct wounds, and wounds inflicted by vulnerating bodies entering through the rectum or the vagina, usually drain well. The outlook for gunshot wounds is favorable in proportion to the freedom with which urine escapes to the surface: hence wounds of both entrance and exit are less serious than wounds of entrance alone. When from lack of thorough drainage extraperitoneal urinary extravasation and cellulitis occur, the symptoms become pronounced at about the end of the first week.

Treatment.—Since extravasation of urine and subsequent septic inflamma-

tion are the main dangers incident to wound of the bladder, the most important indication in the treatment of these wounds is so to provide for drainage of the bladder that there can be no accumulation of urine, and hence no condition favoring escape of this fluid into the peritoneal cavity or the cellular tissues.

When the wound is intraperitoneal, it is safe to assume that blood and urine have already entered the peritoneal cavity. Hence immediate laparotomy is advisable, followed by closure of the bladder-opening by suture, closure of the abdominal wound, if there has been no preceding bladder infection and no evidence of peritoneal infection and permanent catheterization; in case the catheter is repeatedly blocked by clots, either suprapubic or perineal drainage should be resorted to at once. The urine should be rendered antiseptic by the administration of salol or urotropin, and all manipulations must be conducted with the utmost cleanliness, since the wounded bladder is strongly predisposed to cystitis. When the wound is extraperitoneal, suprapubic or perineal drainage is indicated in accordance with the position and direction of the wound. Suture of the bladder is in these cases rarely practicable.

Hemorrhage is treated in accordance with general indications—*i. e.*, when it is moderate, injections of hot lotions (four per cent. solution of antipyrin) may be employed, together with the hypodermic administration of blood serum. When it is severe and persistent, it may require packing, the application of forceps, or incision, exposure of the bleeding points, and ligation, these procedures being supplemented by direct transfusion.

Peritonitis requires immediate laparotomy, cleansing, and thorough drainage.

Pelvic cellulitis is treated by free incisions carried deep into the perineum, the ischiorectal fossa, over the pubis into the space of Retzius, or wherever else there is a uro-purulent infiltration.

Contusion of the Bladder.—Contusion of a healthy bladder without rupture of its walls, though proved to be possible by a few reported cases, is probably a rare form of injury. Theoretically it may be produced by the causes which occasion rupture of this viscus, particularly by force applied to the anterior abdominal wall when the bladder is overdistended. It is easy to imagine that if this force is concentrated it may cause rupture of some of the blood-vessels lying in or beneath the mucous membrane, and thus may cause bleeding into the bladder.

The symptoms of this injury are commonly partial or complete retention, tenesmus, pain, tenderness, and the passage of blood-stained urine and of clots. Shock should be moderate or altogether wanting. It is possible, particularly in a bladder which has been the seat of disease, that bleeding may be persistent and severe.

The diagnosis is of importance, since this injury must be distinguished from rupture. Examination with the cystoscope after bleeding has stopped may aid in excluding rupture. Most reliance can be placed on injection of the bladder with a measured quantity of antiseptic solution. If such a solution is forced in under moderate pressure, is retained for two or three minutes, and on being withdrawn by a catheter is found to have lost nothing in volume, it is fair to assume that there is no breach in the continuity of the vesical wall.

Treatment.—The treatment of contusion depends entirely on the severity

of the symptoms. When bleeding is slight and there is little or no retention, rest, the mouth administration of urinary antiseptics, and the control of tenesmus and pain by hot baths, hot abdominal compresses, and opium and belladonna suppositories will fulfil the therapeutic indications. Even when there is some obstruction by blood-clots to the free passage of urine, it is well to abstain from interference, provided dirty instruments have not been passed into the bladder previously and the urine is sterile. Should retention become well marked, a sterile, full-sized catheter should be passed immediately, under the antiseptic cautions described when treating of retention, and the clots sucked out by a syringe, or, if this fails, by means of the large evacuating catheter and aspirator of a litholapaxy instrument. If there is persistent bleeding, continuous catheterization is indicated. Should the hemorrhage be profuse, suprapubic cystotomy should be performed; the bleeding points can then be subjected to direct treatment. If there is cystitis, clots should be evacuated, even though there is no retention, and the bladder should be irrigated twice daily with a mild antiseptic solution (silver nitrate 1 to 1000, boric acid four per cent., or Thiersch's solution).

Rupture of the Bladder.—This injury may be either intraperitoneal or extraperitoneal. It may be traumatic or pathological. So-called idiopathic cases are always secondary to some obstructive or degenerative factor. It usually occurs at about the prime of life.

The causes of rupture of the bladder are predisposing and exciting.

Of the predisposing causes the one of greatest importance is the condition of distention. Indeed, it is difficult to imagine how the empty viscus can be ruptured unless there are extensive concomitant injuries.

Alcoholism is a predisposing factor, but mainly because it tends to encourage a condition of overdistention of the bladder, from the fact that it stimulates the kidneys, and so obtunds sensibility that the desire to micturate is not noticed, even when the bladder is full.

Fixation of the bladder by pelvic cellulitis, degeneration of its walls from chronic cystitis or atheroma, and disturbed innervation, may also be counted as predisposing factors.

The exciting causes are fracture of the pelvis, separation of the pubic symphysis, violence applied either directly or indirectly, and muscular strain. Thus, kicks in the stomach, falls upon the ischium, and the straining incident to parturition, defecation, urination, or lifting, have caused this injury.

Vesical tension from acute retention of urine, or from injections practised for the cure of cystitis or in the preparation for stone operations, may cause rupture of the bladder without the intervention of strains of traumatism.

Thus, Dittel performed suprapubic cystotomy for the removal of a stone in a child aged three. The bladder was injected with not more than three ounces, and the colpeurynter contained not over four ounces. The patient perished the next day in collapse, with symptoms of pericystitis. In the posterior wall of the bladder there was found a tear two-fifths of an inch in length, running into a diverticulum. This caused infiltration of the pericystic cellular tissue.

Pathological rupture—that in which the bladder-walls give way from over-

distention, without the intervention of force—is usually due to an enlarged prostate, since, in the case of stricture, the urethra usually ulcerates posterior to the seat of narrowing, and tension is relieved by extravasation of urine into the periurethral cellular tissues. It is probable that the majority of cases of rupture attributable to muscular strain will exhibit pathological changes incident to urethral obstruction, the great thickening of the bladder-walls occasioned by such obstruction proving no safeguard against this accident. Cystitis in these cases is usually complicated either by ulceration or by sacculation, thus leaving a weak portion, which may rupture from slight causes.

The seat of rupture may be either intraperitoneal or extraperitoneal. Fenwick states that it is intraperitoneal in eighty-eight per cent. of cases. Ulmann estimates the proportion at eighty-five per cent. The greater frequency of intraperitoneal rupture is partly due to the fact that the area covered by the peritoneum is larger and is less reinforced by the pressure of closely attached surrounding tissues. Moreover, the peritoneum is less elastic and distensible than the other coats, and, splitting suddenly, tears the muscular and mucous coats with it. Direct force applied to the hypogastric region usually causes a tear of the upper posterior bladder-wall. Ruptures due to fracture of the pelvis and spontaneous ruptures are apt to be extraperitoneal. The rupture is commonly single, is vertical or oblique in direction, and when intraperitoneal the peritoneal aspect is most extensively torn.

Symptoms.—The symptoms of rupture of the bladder are a sense of something giving way within the abdomen, hypogastric pain, often agonizing, constant desire to urinate, passage of a few drops of blood, or of blood-stained urine, or failure to pass anything, and shock.

Following these symptoms, under appropriate treatment reaction usually takes place, and there is a period, varying from hours to days, during which the patient suffers from pain and tenderness in the hypogastric region, tenesmus, and a constant desire to micturate, and passes little or no urine.

Exploration of the hypogastric region demonstrates percussion dulness and a sense of resistance closely simulating that of a distended bladder, while rectal examination may show effusion into Douglas's cul-de-sac or the cellular tissues lying at the base of the bladder. There then follows, in accordance with the location of the rupture, either septic peritonitis, usually terminating fatally in five days, or cellulitis, which progresses more slowly, and is attended with the symptoms of septicæmia, sometimes running a course of several weeks.

Diagnosis.—The diagnosis of rupture of the bladder is founded upon the history of the case, the symptoms already detailed, notably shock, tenesmus, urgent desire to micturate, which the patient cannot satisfy, or frequent urination and the passage of blood, and upon the results of direct examination. All the subjective symptoms may be excited by contusion of the abdomen; if there is also contusion of the bladder the urine will contain blood. The bladder may be ruptured without exciting a single characteristic symptom. Coates reports two cases of rupture of the posterior wall in which the lesion was not suspected during life, no signs of acute peritonitis having developed. The peritoneal cavity was flooded with sterile urine; death was attributed to absorption of the urine by the peritoneum, with a consequent toxic effect upon the blood. In

two of thirty-five cases collected by Nobe, the urine contained no blood. In both cases the rupture occurred at the vertex, the least vascular part of the bladder.

The simplest method of exploration consists in the passage of a thoroughly sterilized silver catheter through the urethra, first flushing it thoroughly with a 1 to 4000 protargol solution. If this draws off bloody urine and clots, the probability of rupture is strong. If on manipulation of the shaft so that the tip is made to traverse the inner surface of the bladder this tip repeatedly catches at one point, and apparently can be passed through the bladder-wall, so that it can be felt immediately below the skin or mucous membrane surface by palpation in the hypogastric region or through the rectum, there can no longer be doubt about the existence of a rupture.

Better than this means of exploration is the irrigating cystoscope if it be available.

The injection of an antiseptic solution is by no means an infallible test, since even an extensive rupture may so quickly close by inflammatory adhesion that a solution injected with gentle pressure fails to break this down, and the total quantity injected is at once returned.

Weir states that this injection method (Cabot's) is made more reliable by several repetitions, enough fluid being driven in each time markedly to distend the bladder. The method is rendered still more serviceable by preceding the injection by a careful digital examination of the rectum, followed by the insertion and distention of the Barnes bag. The bladder is then injected with a known volume of fluid. If there results rapid increase in pelvic tumor and dulness, as detected by suprapubic examination, this must be due either to the distended bladder or to extravasated fluid. In the latter event failure to recover by catheterization all the fluid injected will show the presence of an extraperitoneal rupture. In case there is developed no suprapubic dulness, but all the fluid is not recovered, there must be either an intraperitoneal or a subperitoneal postero-inferior rupture. In the latter case withdrawal of the Barnes bag and a second digital examination of the rectum will show the increase of extravasation. The injection of air is not more reliable as a means of diagnosis than is that of water. When facilities are offered for this, collargol injections and skiagraphy should give reliable findings.

In case of doubt there should be no hesitation in performing either a suprapubic or a perineal cystotomy and thoroughly exploring the bladder by the finger and by sight. Always, when instruments are used for diagnostic purposes, the principles of surgical cleanliness must be minutely observed, and if a rupture is found, operation should be performed at once.

Prognosis.—Rupture of the bladder results fatally in a large proportion of cases, and the prognosis is particularly grave when the rent is complicated by fracture of the pelvis and when it is intraperitoneal, death resulting in the great majority of these cases in the first five days. Spontaneous recovery, though possible, is so rare as to constitute a surgical curiosity. The extraperitoneal tears are somewhat less fatal, but in the absence of proper surgical intervention the majority of these perish. The prognosis is undoubtedly better to-day, when antiseptics are generally employed in the treatment of bladder-

lesions, than in the former septic period. The urine when first extravasated from a healthy bladder is a sterile fluid and does not cause inflammation. Hence, if not infected by the use of dirty instruments, it undergoes changes slowly.

The conditions for germ-growth are, however, so favorable that the slightest infection is followed by rapid and extensive suppuration. The mortality, if that from shock incident to associated injuries be excepted, is inversely proportional to the timeliness of surgical intervention.

Causes of death are most frequently peritonitis (seventeen of twenty-six cases), shock, and hemorrhage.

Schlanger notes ten recoveries out of twenty-two operations for intraperitoneal rupture. Seven out of ten were cured when the rupture was extraperitoneal.

Treatment.—If the wound is intraperitoneal, an immediate laparotomy, siphoning of the extravasated blood and urine from the peritoneal cavity, and closure of the bladder by suture are indicated. It is important that this operation should be performed immediately—that is, before the beginning of peritonitis. When exploration fails to show whether the rent is intraperitoneal or extraperitoneal, suprapubic cystotomy should be performed and a diagnosis thus made; if further room is required, the midline incision may be carried upward or the sheaths of the recti muscles may be split transversely and the muscles widely retracted.

The sutures by which intraperitoneal bladder-wounds are closed are placed about six to an inch; the first row, preferably of fine sterile catgut, closes the rent, each stitch including all but the mucous coat of the bladder; this line of union is then turned in by a second row, the suture being of silk and made continuous. The peritoneal surfaces are then brought in apposition, and inflammatory agglutination takes place in less than twenty-four hours. When the sutures have been properly applied in healthy non-infected tissue there is no tendency to the reopening of the wound. To make sure that the wound has been thoroughly closed, the bladder should be moderately distended with mild antiseptic solution; if apposition is perfect there will be no leakage. When septic peritonitis has already developed, tube drainage is indicated. In large, irregular, contused or lacerated wounds of a diseased bladder the line of suture cannot be trusted. The wound should be rapidly closed by a continuous catgut suture, reinforced by the omentum held in place by a few stitches.

When suprapubic cystotomy has been performed for exploratory purposes and the rent is found to be extraperitoneal, it should be thoroughly cleansed and closed by interrupted suture. The results, so far as the closure of the wound is concerned, are not so satisfactory as those obtained by the suture of intraperitoneal openings. Hence a drainage-tube or a rubber-wrapped gauze wick, or both, should lead to the seat of injury, thus providing for the free escape of urine in case the sutures should give way.

The after-treatment of operation for bladder rupture consists in the employment of continuous catheterization for them three to eight days, after which the patient is allowed to void naturally if he can, otherwise intermittent catheterization is practised at such intervals that the bladder is not allowed to retain

more than ten or twelve ounces of fluid. The method of using continuous catheterization is the same as that described under the treatment of retention from prostatic enlargement. Extraperitoneal ruptures are treated by permanent catheterization, supplemented by antiseptic irrigation of the bladder practised night and morning. If the surgeon distrusts the permanent catheter, as he should do in most cases with extensive and complicated wounds, suprapubic drainage or the insertion of a tube through the perineum is indicated.

Pain, particularly that referred to the rectum and running down the thighs, rigors and fever, and leucocytosis of the polymorphonuclear type, point to extravasation and cellulitis, and indicate either a suprapubic or a perineal cystotomy. The suprapubic operation is preferable unless œdema, tenderness, and swelling, which may be evident only on rectal examination, show that the perineum is the seat of infiltration.

FISTULA OF THE BLADDER

Vesical fistula is an anomalous tract leading from the bladder to the surface of the body or to some neighboring viscus. It is usually due to the failure of a surgical or an accidental wound to heal, but may be caused by erosion from a calculus or foreign body, burrowing of a pericystic abscess, or ulceration of a tuberculous or malignant infiltration. The fistulous tract may run directly or deviously to the surface. The nomenclature of these fistulæ is indicative of their course: thus, they are termed vesicoperineal, vesicohypogastric, vesicogluteal, etc. Pathologically these ulcerating channels are identical with urethral fistulæ; they may burrow in many directions and open by several orifices; they often develop lateral blind diverticula, and they become densely indurated.

Symptoms.—Cystitis is a symptom common to all forms of long-standing vesical fistula. Other symptoms vary in accordance with the seat of the extravesical opening. When this is upon the skin surface there is an obvious escape of urine.

The urine may dribble almost constantly or may flow intermittently. When the tract is narrow, and particularly when the opening in the tract is valvular, the quantity escaping will be insignificant. When conditions the reverse of these obtain, all the urine may pass through the abnormal opening. The skin surrounding the external opening of the fistula shows the excoriation, inflammation, and infiltration described when treating of urethral fistulæ. During the act of micturition, or when intra-abdominal pressure is increased by muscular contraction, as in the act of lifting, coughing, or defecation, there is increased flow of urine from the opening.

When the fistula opens into the rectum, if the channel of communication be narrow, there may be no symptoms suggesting this communication other than a urinous discharge occurring often with the passage of well-formed stools. Usually, however, the symptoms of this fistula are sufficiently characteristic. There is a more or less constant escape of urine from the rectum, and gas and fæces are passed by the urethra. We have seen a case due to cancer of the bowel, in which nearly all the fæces were passed by the urethra for several months. Fecal masses, by blocking the urethra, often cause retention of urine. Cystitis under such circumstances is very severe.

When there is communication between the bladder and the small intestines or the colon, in the latter case usually by way of the appendix or a diverticulum, gas, remnants of food, and traces of bile will be passed per urethram, but the solid particles found in the urine probably will not exhibit the characteristics of fæces. There will be no urine escaping by the rectum, or none which can be recognized as such, since it is thoroughly mixed with the rectal contents.

Diagnosis.—When the fistula opens externally the diagnosis is based on—1, escape of urine, particularly marked during abdominal straining; 2, escape of colored fluids injected into the bladder or methylene blue given by mouth; 3, urethral examination, a sound being passed into the bladder and a fine probe being introduced along the fistulous tract; 4, cystoscopic examination; 5, injection of hydrogen peroxide along the fistulous tract, bubbles then escaping per urethram at the next act of micturition; 6, palpation, an area of induration sometimes being perceptible from the external opening directly to the bladder-wall.

When the fistula opens into the bowel the diagnosis may be more difficult. The passage of air at the end of micturition is in itself pathognomonic. The detection of fragments of fæces in the urine, the finding of urinary salts in the liquid passed per anum, the detection of an opening into the rectum by direct examination through a speculum, the finding of a bladder-opening by the cystoscope, and particularly the discovery of a sufficient cause for such a lesion, as, for example, malignant or tuberculous ulceration, or large stone, or the history of appendicitis, would lead to a correct diagnosis. Colored solutions, such as methylene blue, if injected into the bladder, or if administered by mouth, may appear in the stools, thus positively establishing the existence of a vesicorectal fistula.

The differential diagnosis between vesical and urethral fistula is based upon the fact that urine escapes from the latter only during or after micturition, and that colored fluids injected into the bladder will not escape through the fistulous opening until the patient urinates.

Treatment.—Fistulæ due to tuberculous and malignant infiltration and ulceration are incurable. The appropriate treatment is that directed against the cystitis. Perineal or suprapubic drainage may be required. Fistula following operation, if small and comparatively recent, may be cured by continuous catheterization, combined with antiseptic washing of the bladder and cauterization of the fistulous tract, preferably with the galvanocautery. This failing, the fistula should be laid open to the bladder, its walls dissected out, and the wound treated as it would be after the operation of cystotomy.

When the fistula opens in the gluteal region or in the neighborhood of the hip-joint, after a preliminary effort at closure by catheterization median perineal lithotomy should be performed, and the bladder should be drained immediately through this opening.

Small rectovesical fistulæ not due to tuberculous or malignant infiltration are treated on the same general principles. At first catheterization should be tried, combined with cauterization of the fistulous tract through the rectum, after which a permanent catheter should be worn with the patient in ventral decubitus. This failing, if the tract is extraperitoneal—that is, if it lies below

the rectovesical peritoneal fold—it may be operated on as described in the treatment of urethrorectal fistula.

When the fistulous tract is intraperitoneal and when it persists in spite of the palliative means described, a formal operation is indicated, since the ultimate outlook of these cases if untreated is bad, death resulting from ascending nephritis. Immediately preceding the operation the bladder should be thoroughly irrigated with dilute antiseptics, preferably freshly prepared protargol, 1 to 4000. This is followed by irrigation of silver nitrate 1 to 500. The peritoneum is then opened just above the pubis, the communication between the bowel and the bladder is rendered accessible, and the intraperitoneal operative area is packed off from the general peritoneal cavity by gauze sponges; the bowel is then dissected loose, the opening into it is closed by Lembert sutures, the first continuous and including all its coats except the epithelial layer of the mucous membrane, the second (Lembert) including only the peritoneal, muscular, and submucous investments.

In the after-treatment the bladder is drained for from three to five days by permanent catheterization, and is irrigated twice daily with lotions of protargol, 1 to 4000, boric acid four per cent., or salicylic acid one-tenth per cent.

CHAPTER XXII

SURGERY OF THE BLADDER—(Continued)

INFECTIONS OF THE BLADDER

CYSTITIS

Cystitis is an inflammation of the bladder due to germ-infection.

The sudden acute congestion due to retention, chilling, irritating conditions of the urine, or foreign body, is not considered as a true inflammation, since, unless there is added to this congestion germ-infection, the condition is transitory, and is attended by no lesions, barring vascular engorgement. Yet while the congestion lasts the symptoms, with the exception of pus and microörganisms in the urine, are identical with those of acute cystitis.

Classification.—Cystitis, in accordance with its clinical course, may be acute or chronic. From the pathological standpoint the disease may be—

1. Superficial or catarrhal.
2. Interstitial.
3. Pericystic.

Further subdivisions, sufficiently indicated by their names, are pseudomembranous cystitis and gangrenous cystitis.

Etiology.—The causes of cystitis are predisposing and exciting. The predisposing causes are those which favor congestion and retention, the latter condition implying the former, since an overfull bladder is always congested. A normal bladder containing normal urine which is evacuated at proper intervals is not readily infected. Even though germs be carried directly into its cavity, by dirty instruments for instance, the resistance of the healthy tissues is sufficient to prevent penetration and multiplication of microörganisms.

The causes of vesical congestion are—1. Retention of urine. The vesical congestion is in proportion to the acuteness of the retention: hence a sudden distention of the bladder is a more favoring factor in the development of cystitis than is a gradual accumulation of urine. 2. Trauma. This may be due to jar, strain, contusion or laceration, rough instrumentation, or bruising by a stone or other foreign body. 3. Muscular contractions abnormally frequent or prolonged. These may be excited reflexly by lesions, irritations, in inflammations of the rectum, sexual organs, kidneys, or urethra, or may be due to hypersensitiveness of the micturition centre, to habit, or to polyuria. 4. Abnormal conditions of the urine. If the urine is essentially changed in any of its characteristics, it will eventually act as an irritant to the vesical mucosa. If it is strongly acid, markedly alkaline, or of very low or very high specific gravity, it occasions congestion. Thus, the gouty and rheumatic, dyspeptics suffering from oxaluria, phosphaturia, or other urinary changes, diabetics, cachectics with hæmaturia, persons who have been severely burned, and those who have ingested overdoses of such drugs as cantharides, turpentine, the balsams, alcohol, or

arsenic, are predisposed to cystitis by vesical congestion. 5. Tumors and calculi. It should be borne in mind that tumors and calculi do not in themselves cause cystitis, but merely predispose to its development by the congestion which their presence occasions, and by the admixture of blood with the urine, thus rendering it alkaline and peculiarly rich as a culture fluid. 6. Surface chilling, as from getting the feet wet or sitting on the damp ground, may cause a sudden and very marked congestion of the bladder, though never a true cystitis. 7. Prolonged sexual excitement or excess in sexual intercourse is a potent factor in the production of bladder hyperæmia. 8. Cardiac weakness, venous obstruction, and atheromatous degeneration of the vessels are factors often operative in the aged, which when combined, as is often the case, with an enlarged and inflamed prostate, and hence with retention of urine, make the development of cystitis nearly certain. 9. Lesions of the central nervous system by destroying vasomotor control and favoring retention of urine strongly favor the development of cystitis.

Congestion of the bladder is, then, the condition which most predisposes to cystitis. When to the congestion is added retention, particularly if of an alkaline and albumen- or blood-containing urine, the most favorable conditions for germ-infection are present. It is clear that several of the causes of acute congestion may be operative at the same time: thus, during acute fever there may be atonic retention of urine which is irritating from the pyrexia; or after spinal injury there may be vasomotor dilatation, combined with retention from detrusor paresis.

The exciting cause of cystitis is local infection. This infection is commonly due to catheterization or urethritis. The microbes may also enter the bladder from the kidneys, by the agency of the blood- or lymph-channels, or they may pass directly from the rectum, this direct passage being particularly liable to take place in cases of constipation, inflammation, hemorrhoids, or tumors of the rectum, as shown by Wreder.

Pericystic suppuration may also occasion local bladder-infection by destroying the bladder-wall and discharging pus into its cavity.

Normal urine is usually sterile. In the urine of cystitis have been found a great number of organisms, many of them without pyogenic action. Of the microörganisms which occasion cystitis the colon bacillus is the one most frequently found. After this come the staphylococci and streptococci of ordinary pus and the bacillus proteus vulgaris. It seems clear that the gonococcus may invade a part or even the whole of the trigonum, but there is evidence that the remaining vesical mucous membrane is at least partially immune to its attack. Cases of true bladder-inflammation traceable to gonorrhœa are usually due to mixed infection. This is also true of post-typhoid cystitis, though cases are reported in which the urine contained pure typhoid cultures.

The tubercle bacilli will be discussed under the head of Tuberculosis of the Bladder. In themselves they are not able to cause general cystitis, but they strongly predispose to mixed infection.

Bilharzia, a parasitic disease indigenous to the tropics, especially Egypt, is caused by the *Schistosomum hæmatobium* (Bilharz). The early stages of the disease in the bladder are characterized by small elevations of the mucosa,

especially on the trigonum, the only symptom being a painless hæmaturia. Later the walls of the bladder become enormously thickened, usually containing calcareous deposits, while the interior of the viscus is more or less completely filled with a sloughing, papillomatous mass, in which are mingled large quantities of blood and pus. At this stage there is frequent, painful urination, sometimes complete retention of urine; the external genitalia, ureters, and kidneys have also commonly become extensively involved.

Diagnosis is made from the cystoscopic appearance, and the finding of the typical ova in the urine.

Treatment is entirely symptomatic.

Germs exert their injurious action upon the bladder-tissue either directly or through their ptomaines. The inflammation they produce is increased by the ammoniacal fermentation of the urine which they bring about. This fermentation is due to the decomposing action of microbes upon urea, ammonium carbonate being formed. This converts the pus into a ropy, gelatinous mass, renders the urine markedly alkaline, and makes it thick, foul, and ammoniacal. The proteus group produce this ammoniacal fermentation; the urine in cases of cystitis due to most other organisms is usually acid.

Cystitis has for its seats of predilection the trigonum. It is in this region particularly that the most pronounced lesions are usually found, even though the entire vesical mucous membrane is involved.

Superficial or catarrhal and ulcerative cystitis in its acute form is characterized by a reddened, œdematous, ecchymotic mucous membrane the vessels of which are markedly engorged. Erosions or distinct ulcerations may develop. Exceptionally shreds of necrotic mucous membrane are passed. The urine is usually acid, and contains pus and much bladder epithelium.

Vesical ulceration occurs in the following forms: (*a*) traumatic; (*b*) inflammatory, including simple pyogenic and tuberculous; (*c*) malignant, and (*d*) simple or solitary, described also as embolic, perforating, or idiopathic. The last group, described by Fenwick, is not definitely understood, and has probably been often mistaken for tuberculosis. These ulcers are usually single, and located to the inner side of the ureteral orifice on the posterior wall, but not actually on the trigonum. They are comparable to gastric ulcers, and may perforate.

When superficial cystitis becomes chronic, reddening of the thickened mucous membrane is no longer pronounced. Indeed, this may assume a yellowish hue with prominent veins and areas of exfoliation colored gray-white by thin layers of pus or urinary salts. From the œdematous and congested mucous membrane small polyps may grow, and the inner surface of the bladder is often trabeculated from muscular hypertrophy.

The urine is generally alkaline; when markedly so from ammoniacal fermentation, there is often found overlying the mucous membrane a dirty-whitish deposit of muco-pus.

Interstitial cystitis exhibits the mucous membrane lesions of a superficial inflammation. The inflammation extends more deeply, however, involving particularly the connective tissue, but not entirely sparing the muscular fibres. From the inflammatory infiltration the folds of the mucosa become prominent,

causing ridges to be formed, which are readily felt on exploration by a sound. The bladder-walls may become enormously thickened. Small abscesses develop in the submucous connective tissue or in the muscular coats. These abscesses commonly open into the vesical cavity, leaving diverticula which are slow to heal. Exceptionally such abscesses extend outward, involving the perivesical tissues and resulting in localized pelvic cellulitis or in peritonitis. If the active disease is arrested, organization and cicatrization take place, producing more or less distortion and contraction, sometimes sufficient to lessen greatly the vesical capacity (Fig. 244).

Localized Cystitis.—Under this heading Geraghty[1] describes a variety of lesions, all characterized by their discrete character, but varying from a

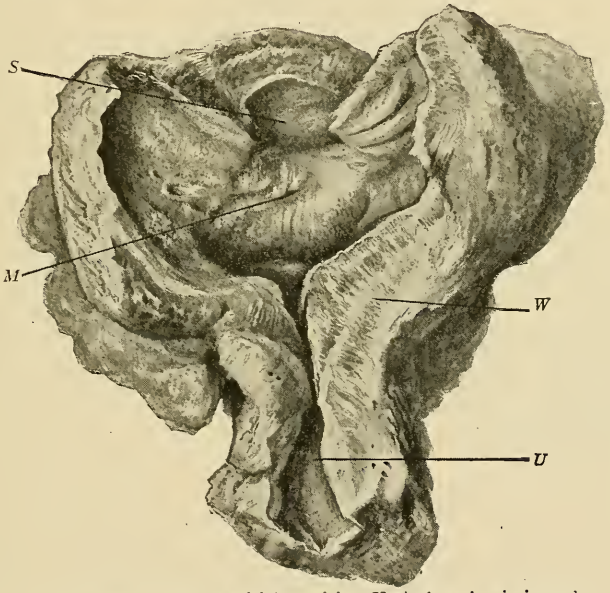


Fig. 244.—Interstitial cystitis. Vesical cavity is irregular in shape; M, mucosa, roughened and leathery; S, sacculation; W, wall of viscus greatly thickened; U, urethra. (No. 69-5-6, Museum of Pathology, University of Pennsylvania.)

simple hyperæmia to ulceration. The most deeply seated lesions give the cystoscopic appearance of puckered and scarred pale areas; in such cases the infiltration extends deeply into the muscular coat, and cure can only be effected by radical measures (excision or deep cauterization).

Cystitis Cystica is a nodular, glandular condition characterized by the appearance of small nodules disseminated over the bladder surface resembling tubercles. This comparatively rare affection of the bladder, an entity in itself, is merely classified under "Cystitis" for the sake of convenience (Fig. 245). The nodules are strictly of epithelial formation of a pseudo-glandular type; in cross-section they are irregularly circular or oval in form and are lined by epithelial cells. They are filled with fluid of mucoid or colloid character, con-

[1] "Surgery, Gynecology and Obstetrics," 1917.

taining desquamated epithelial cells and detritus. The cysts vary considerably in size, being small when deep-seated, larger and distended near the surface (Fig. 246). The theory has been advanced that these epithelial nests are primarily inclusions by the connective tissue of the overlying proliferate epithelium. Clinically, the condition is of importance, inasmuch as these cystic formations are prone to undergo carcinomatous degeneration.

Membranous cystitis, variously described as exfoliative, croupous, diphtheritic, and desquamative, is characterized by the discharge through the urethra or through a wound of the bladder of flakes, masses, or complete moulds of the

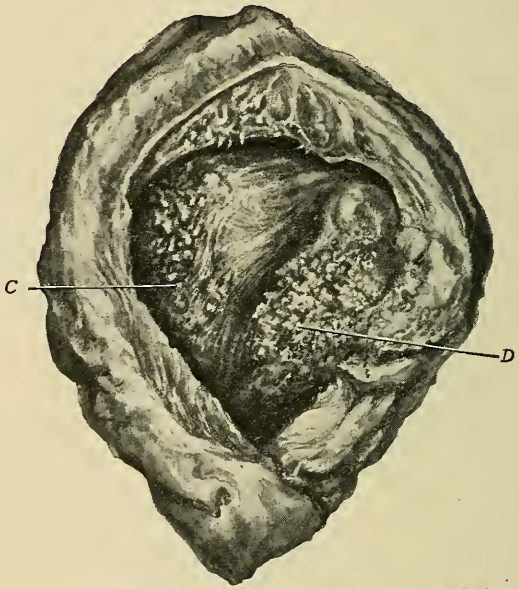


FIG. 245.—Cystitis cystica. *D*, part of the vesical mucosa has undergone carcinomatous degeneration; *C*, area of epithelial cystic formation. (No. 1211. From the Laboratory of Surgical Pathology, University of Pennsylvania.)

bladder, made up of tough, fibrinous, structureless membrane containing the remains of broken-down epithelium.

Stein states that of fifty reported cases, forty-five occurred in women, and mostly in connection with labor or with serious uterine troubles. The pathology seems to vary somewhat in different cases. Thus, Cabot, in practising suprapubic cystotomy, peeled off a thick membrane composed almost entirely of epithelium. Adami holds that true exfoliative cystitis is practically a necrosis of the inner layers of the bladder.

Gangrenous cystitis is characterized by sloughting of the mucous and muscular coats of the bladder. It is occasionally noted in acute septic processes, in cancer of the bladder, and as a sequel to extensive trauma.

PERICYSTITIS is separately considered.

SYMPTOMS OF CYSTITIS.—There are no subjective symptoms which point

exclusively to cystitis—pain, frequent micturition, and pus in the urine, symptoms usually considered diagnostic of bladder-inflammation, being present when the prostatic urethra alone is involved.

The symptoms of cystitis are—1, pyuria; 2, frequent urination; 3, pain; 4, muscular spasm; 5, hæmaturia; 6, fever.

Pyuria.—With pus there is frequently found blood, and there is always a superabundance of mucus and bladder epithelium. When the urine is acid, there settles from it on standing a white sediment of pus, and over this a cloud of mucus. When the urine is neutral or alkaline, particularly when ammoniacal decomposition has taken place, there is often a viscid, ropy deposit of mucopus. In chronic cases micturition may terminate by the expulsion of almost pure mucopus.

Microscopical examination of the sediment shows abundant bladder epithelium, pus, often blood, microörganisms, and in alkaline urine triple phosphate crystals.

Fig. 246.—Cystitis cystica. Photomicrograph showing cyst-formation and papillary outgrowth of mucosa.

Frequent Urination.—This symptom develops partly because the bladder-walls are abnormally sensitive to tension, partly because the prostatic urethra is inflamed and hypersensitive. Frequent urination is aggravated by the erect posture, by bodily activity, by jolting or jarring, and by any of the causes which tend to increase congestion of the prostatic urethra. At times the patient is forced to micturate every few minutes, and is absolutely unable to retain his water when the desire is felt; usually, however, it can be retained one or two hours.

The frequent urination which so often accompanies chronic cystitis, particularly when there is a mechanical obstruction to the free passage of urine, may occasion an enormous hypertrophy of the muscular trabeculæ, with a sacculation of the weaker portions of the vesical walls lying between these interlacing fibres. Bladders thus affected are most difficult to cleanse of the ammoniacal urine.

When there is frequent urination and much straining, there may be some kidney albuminuria due to congestion of these organs. Usually the quantity of albumen in the urine is proportionate to the amount of blood and pus which it contains. Exceptionally in chronic cases there may be a leakage through patches denuded of the surface epithelium.

Pain.—This in the acute cases is constant, with exacerbations taking the form of intense burning, with irresistible desire to pass water and violent straining (tenesmus). It is usually aggravated by the act of micturition, and is more or less relieved after the bladder is emptied. Exceptionally, as in the case of stone and acute gonorrhœal prostatocystitis, the pain is most intense after micturition. It is felt in the prostate and bladder, and radiates from there to the hypogastric region, the sacrum, the rectum, the end of the penis, and down

the inner surfaces of the thighs. In very acute cases when there is prostato-cystitis the patient is compelled almost constantly to make violent and most painful straining efforts at urination, with the evacuation of but a few drops of blood-stained water at a time (strangury).

Muscular Spasm.—As a result of inflammation reflex excitability is markedly exalted. It is to the overaction of the sphincter muscles that much of the pain in cystitis is due. These are thrown into tonic contraction, or sphincterismus, thus increasing congestion and exciting pain, very much as do the anal sphincters in acute proctitis. By their tonic contraction they resist the attempts of the detrusors to empty the bladder, yielding only after long effort, and then but partly, thus occasioning strangury; or the contraction may be so obstinate that there is complete retention of urine. Very frequently the tonic spasm is replaced by clonic contractions, which suddenly shut off the stream when it is started, especially when the last few drops are being voided. From the closely connected nerve-supply, the sphincter ani sometimes participates in this tonic contraction, thus adding to the distress.

Hæmaturia.—The passage of almost pure blood, especially when it comes at the end of urination, is characteristic of inflammation of the prostatic urethra rather than of cystitis. After micturition is completed the bleeding may still continue from this region and flow back into the bladder, rendering the urine alkaline and predisposing it to ammoniacal fermentation, with marked aggravation of the cystitis. From the bladder-walls in hyperacute cases there is usually some bleeding. This is slight, and the blood is intimately mixed with the urine.

Fever.—In the beginning of an acute cystitis, fever and the associated symptoms of depression, nausea and constipation, are frequently observed. Fever is not a usual symptom of chronic cystitis. When it reaches a high grade, and is prolonged and paroxysmal in type, it may be taken as a sign that cystitis is not the only cause. In these cases examination usually shows involvement of the prostate in acute cases—an accompanying pyelonephritis in the chronic ones.

Diagnosis.—Frequent urination, pain, and pus in the urine are of themselves not enough to make the diagnosis of cystitis complete.

In cases of chronic inflammation there may be no symptoms except pyuria. When, together with some or all of the symptoms given above, the bladder is tender on suprapubic and rectal palpation, when the urine passed in three portions shows greatest pus-turbidity in the last, when the flat bladder epithelium is very abundant, when intravesical injections show that the bladder is hypersensitive to tension, and when the urine at the time of being passed is ropy and ammoniacal, the diagnosis of cystitis can be made confidently. The further diagnosis in regard to the seat of the inflammation, its nature and extent, and the presence or absence of complicating renal infection is made by cystoscopy and by ureteral catheterization.

Prognosis of Cystitis.—Provided there is no lesion which tends indefinitely to prolong vesical congestion, the prognosis of acute cystitis is favorable. The inflammation which frequently accompanies stone or tight stricture of the urethra, or even enlarged prostate, can be completely cured by removal of the exciting cause. Cystitis due to gonorrhœa or rough instrumentation usually runs a rapid and favorable course. It often happens, however, that some

infection of the mucosa remains, which is stimulated to renewed activity whenever normal emptying of the bladder is interfered with, or when sexual or alcoholic excess or intercurrent disease causes pelvic congestion and irritation. The cure is probably more often relative than absolute, since it is considered established when micturition is accomplished normally and when the urine is apparently clear.

The final conclusive proof of cure should be founded upon the results of microscopic examination of the urine. If the centrifuged sediment of twenty-four hours' urinary secretion is found to be free from pus, the patient may be considered cured. If, on the contrary, pus is found, even though it be in small quantities, perhaps scarcely enough to form shreds, some focus of infection still remains, and is liable to light up an acute inflammation under favoring circumstances.

As a rule, though the active symptoms may be subdued or may entirely disappear, some suppuration persists.

It may happen that from infiltration of the bladder-walls, followed by fibroid change and contraction, the vesical cavity becomes greatly reduced, so that the bladder can contain but a few ounces at a time. More frequently, particularly in the case of prostatics, there is dilatation with an incurably thickened suppurating mucous membrane.

In its relation to involvement of the kidneys, and consequently to the life of the patient, the prognosis of acute and chronic cystitis is somewhat different.

Lipowski states that the conditions favoring ascending infection are moderate retention and a strong, irritable bladder, which drives urine back into the ureter at the moment the orifice of this canal is opened to expel its contents. These conditions are fulfilled in cases of stricture, hypertrophied prostate, acute inflammation, and spastic affections during the first period of cystitis. The inflammation markedly increases the irritability of the yet strong bladder-muscles. Hence it would seem to follow that the greatest danger of kidney infection from the bladder exists in the early stages of cystitis; later, when the submucous and muscular coats are infiltrated and the vesical contractions are feeble, intravesical tension is not sufficiently high to overcome that exerted by the stream of urine descending from the kidney. Tuberculous cystitis, according ot Lipowski, forms an exception to this rule.

Treatment of Cystitis.—From what has been said concerning the cause of cystitis, it is plain that the prevention of this disease depends upon the avoidance of local congestion and of the entrance of germs into the bladder.

Before entering upon the treatment of a case of cystitis the urine should be examined for the purpose of determining its reaction and the degree of acidity or alkalinity as indicated by titration with a decinormal solution of sodium hydrate or hydrochloric acid, and of recognizing the presence of any substances irritating to the vesical mucosa, as oxalate or uric acid crystals. The removal of any urinary irritation is essential to the speedy cure of the cystitis.

Local congestion is avoided by attention to the rules of hygiene. Chilling of the surface, wet feet, prolonged standing, elaborate meals, highly seasoned foods, pastry, sweets, alcohol, and rhubarb are to be avoided. Rest in bed is

not desirable; indeed, in cases of partial urinary retention it seems to favor rather than lessen pelvic congestion. Regular daily exercise in the open air, such as driving, walking, or riding the horse or bicycle, in accordance with the strength of the patient, is to be commended. The diet must be so regulated that digestion is perfectly performed; even slight gastric or intestinal disorders render the urine distinctly irritating.

Usually diluent drinks are serviceable, particularly at night, since the urine is most strongly acid during the small hours. Natural mineral waters may be ordered in accordance with the dyscrasia of the patient. Thus, lithia water would be indicated in the gouty or rheumatic, ferruginous waters in the anæmic or in those subject to looseness of the bowels.

Careful attention should be given to the condition of the skin. The patient should bathe daily in either hot or cold water, according to preference. This bath should be followed by vigorous friction. The sweating-box described under the treatment of syphilis is particularly serviceable, and may be used daily when there is no idiosyncrasy and when it does not produce weakness or debility. The feelings of the patient will be the best guide in deciding on this course of treatment. The sweat should be followed by a cool sponging and vigorous friction.

Regular evacuation of the bowels is a matter of cardinal importance. It has been shown experimentally that rectal obstruction is almost immediately followed by the appearance of enormous numbers of colon bacilli in the urine, coming either through the kidneys or conceivably directly from the thin intervening walls. A daily bowel movement is best procured by exercise and diet. If these means are not efficient, mild salines, such as Hunyádi water, may be administered in the early morning, or rectal enemata of normal saline solution may be given. The nightly ingestion of half to one ounce of paraffin oil is generally beneficial.

When there are local causes for reflex irritability, as hemorrhoids, varicocele, tight prepuce, or narrow meatus, these should receive appropriate surgical treatment. Urethral causes of bladder-irritability or of partial retention of urine, such as stricture of either large or small calibre, should be relieved as promptly as possible. Furthermore, many cases of cystitis are kept up by repeated reinfection from such sources as the kidney pelves, the seminal vesicles, the prostate, occasionally the utricle.

Acute cystitis, or violent congestion typified by cantharidal poisoning, is treated by hot baths, rest in bed, elevation of the pelvis, and thorough evacuation of the lower bowel, best procured by salines and cold enemata of salt water.

For the relief of the frequent painful urination belladonna and opium suppositories are indicated. These should be repeated hourly till they accomplish the purpose for which they are given (extract of opium, one-half grain; extract of belladonna, one-fourth grain). Rectal applications through a catheter by means of a piston syringe, of fifteen to thirty grains of antipyrin and ten to twenty drops of laudanum in one-half ounce of water, are more useful and less disadvantageous than morphine or opium suppositories. Hot compresses should be applied to the entire abdomen, and should be changed frequently. Diluents and sedatives should be given by the mouth. If there is fever with consequent strongly acid urine, to the copious draughts of water should be added potassium

citrate or acetate, in doses of ten grains six times daily, or spirit of nitrous ether in drachm doses hourly, or liquor potassii citratis may be administered in tablespoonful doses well diluted every one or two hours. Salol and boric acid should always be given for the purpose of rendering the urine slightly antiseptic. When the symptoms are unusually severe, patients often assume the knee-elbow position, since thus the pressure of the abdominal viscera is taken from the bladder and venous engorgement is lessened. This position is serviceable, and should be advised when it is not spontaneously assumed.

When the symptoms are purely the result of congestion—*i.e.*, when there is no vesical infection—all intravesical manipulations should be avoided, unless retention threatens, though pain may be relieved promptly and for several hours by the instillation of fifteen drops of a five per cent. solution of eucaine. In cases of gonorrhœal prostatocystitis where the inflammation is limited to the prostatic urethra and portion of the trigonum nearest the vesical orifice, an instillation of ten drops of a five per cent. solution of silver nitrate may give almost immediate relief, or it may make still more intolerable the suffering of the patient.

The bleeding of acute inflammation is usually slight, and is often of advantage, since it lessens congestion; it requires no special treatment.

Should retention supervene, if it is entirely due to spasm and congestion, an attempt should be made to relieve it by a hot general bath, the patient being directed to micturate while still in the tub. Hot compresses or turpentine stupes to the abdomen and full doses of opium and hyoscyamus or belladonna are also indicated. When retention is complete and distention pronounced, there should be no hesitation in employing the catheter, nitrous oxide being given if this manipulation is excessively painful. The catheter may be left in place for several days, until the hyperacute symptoms have subsided (see p. 73).

In the course of a week to ten days the acute inflammation will subside, and, provided there are no local conditions which tend indefinitely to prolong congestion, convalescence may be complete. Usually the disease becomes chronic, and may thus continue for years, giving rise to no symptoms other than a small quantity of pus in the urine, but being subject to acute exacerbations.

Treatment of chronic cystitis will not be successful unless the predisposing causes, such as urethral obstruction, stone, and tumor, are removed. The diet should be so regulated that the food is thoroughly digested and the gastro-intestinal tract kept free from irritation; highly seasoned articles, desserts, and alcohols are in general to be avoided. The natural mineral waters are useful as diluents, and may be taken between meals. Saline diuretics—and among these potassium citrate is the most valuable—should be given, well diluted, in quantities sufficient to keep the urine nearly neutral in reaction. In the absence of a rheumatic diathesis, and particularly where there is an associated anæmia, the ferruginous mineral waters are of use.

Of the long list of drugs used by the mouth comparatively few have any real value. Benzoic acid often does good when the urine is markedly alkaline. It may be given in five- to ten-grain doses six times a day. The dose is

regulated by the effect upon the urine. Acid sodium phosphate in half-drachm doses every three hours is a useful drug for acidifying the urine and relaxing the bowels. Hexamethylenamine is sometimes useful an a urinary antiseptic when the urine is distinctly acid, in doses of not less than forty grains a day; it is useless when the urine is either neutral or alkaline. Care must be used that it does not cause irritation of the bladder or kidneys. The balsams are extremely useful in both subacute and chronic cystitis. Santyl, an ester of sandalwood oil, is particularly serviceable, but should be given in fairly full doses.

Of the many other drugs which have been recommended and which are commonly employed, perhaps the most useful are pichi extract five grains every two hours in capsules; cantharides in drop doses every one or two hours as a stimulant in extremely chronic cases; turpentine five to fifteen drops in emulsion every three hours; oil of eucalyptus five to ten drops in emulsion every two hours; fluid extract of buchu or uva ursi in drachm doses every two or three hours; arbutin in doses of three to five grains three to six times daily.

Generally, if predisposing causes are removed, and the urine rendered unirritating, stimulant, and slightly antiseptic, so that ammoniacal fermentation does not take place, the symptoms rapidly improve, and the patient recovers. If, however, these milder hygienic and medicinal methods fail and free vesical suppuration continues, local treatment is indicated. This may be applied either by instillation or by irrigation.

The method of employing instillation has been described already under the treatment of posterior urethritis. Irrigations are practised with a fountain syringe fitted to either a short urethral nozzle or a soft rubber catheter of comparatively full size. Irrigations with a short urethral nozzle may be employed when the vesical tonicity is good and the bladder has the power of completely and painlessly evacuating its contents. In chronic cystitis this condition is rare: hence the method of choice is usually that with the catheter.

Instillations are indicated when inflammation is particularly severe at or about the neck of the bladder. This is usually shown by the symptoms, strangury being always most pronounced when inflammation is thus located. These instillations act directly upon the prostatic urethra and the neck of the bladder. They may at first seem to aggravate tenesmus and pain, but this is shortly followed by marked relief. The solutions of choice are those of silver nitrate with a maximum strength of five per cent. It is well to begin with a one-half per cent. solution and gradually increase the strength till the symptoms are relieved.

Minet advises instillations two or three times a week of two to four cubic centimetres of two per cent. aqueous solution of pyrogallic acid to relieve painful frequency of micturition.

Instillations are repeated every second, third, or fourth day, in accordance with the reaction they excite. The immediate pain they cause may be lessened by preceding them by an application of eucaine. When it is desired to affect a larger surface of the bladder, two to four drachms may be employed. The strength of the silver solution when it is thus used should not be more than one per cent. When the treatment is inaugurated it is well to begin with half a

grain to the ounce. Silver nitrate instillations are particularly serviceable in gonorrhœal cystitis, and in those chronic, non-tuberculous forms of inflammation which are not dependent upon urethral obstruction and retention.

Sublimate instillations are useful in tuberculous cystitis. They also render good service in the inflammation due to gonococci, colon bacilli, and ordinary pyogenic microbes. This method of treatment was first popularized by Guyon, who reported extraordinarily successful results. The quantity injected into the bladder should be from one to two drachms, and that into the posterior urethra from five to fifteen drops. Weak solutions are first employed (1 to 4000), and the strength is gradually increased (1 to 500). These instillations may be repeated every second or third day, and should be preceded by irrigations unless the bladder is extremely irritable.

Irrigations are given with strict attention to cleanliness. The quantity injected varies in accordance with the capacity and irritability of the bladder. It is a good rule not to inject a sufficient bulk of fluid to cause pain from tension.

The most efficient irrigation is that of the silver salts. The solution employed varies in strength from 1: 10,000 to 1: 500. In extremely chronic cases much stronger solutions than these are not only tolerated but are beneficial. The urine is first passed. The bladder is then irrigated with boiled water until this comes away clear; finally one or two ounces of the silver solution are thrown in and allowed to escape almost immediately. Strong silver irrigations are repeated daily or every second or third day, in accordance with the violence of reaction. When they excite severe pain and apparently aggravate symptoms—and this is particularly likely to occur in tuberculous cystitis—other antiseptics should be employed. After silver nitrate the most efficient lotions are those of potassium permanganate (1: 6000 to 1: 500), boric acid (five to fifteen grains to the ounce), salicylic acid (1: 1000 to 1: 10,000), and ichthyol (1: 1000 to 1:50, in normal saline solution). When even the weakest of these antiseptics occasions pain and marked reaction, and when it is certain that these sequelæ are not due to bladder-tension incident to the injection of too great a quantity at one time, recently boiled nine-tenths per cent. sodium chloride solution may be employed.

It should be clearly understood that in cases of chronic cystitis the bladder mucosa is infected not only upon its surface but also in its depth, and that no antiseptic can reach germs which are embedded in the tissues. The function of lavage is not to render the bladder-wall sterile, but rather to remove decomposing pus and urine, to inhibit or destroy those germs which lie upon the surface, to stimulate healthfully the chronically engorged vesical walls, and to leave in the bladder a residuum which will prevent further fermentation of the urine, with its irritating effect upon the mucosa. It is therefore well, after having practised irrigation, to leave from half a drachm to an ounce of antiseptic solution in the bladder. This is particularly indicated when evacuation of the last few drachms of urine is painful.

No rule can be given as to the number of irrigations which are indicated. Where there is profuse suppuration with rapid decomposition, ammonuria, and retention, the bladder should be washed out at least twice daily, and often this process can be advantageously repeated three or four times. Where the cystitis is slight in grade and the urine is not decomposed, irrigations may be

practised every two or three days. Daily irrigation at least is generally required.

When in spite of instillations and irrigations, or because of pain, spasm, and undue reaction, these methods of treatment are not practicable, the cystitis becoming steadily worse, and constitutional symptoms developing, permanent catheterization is indicated. The technique of this method is fully described under the treatment of retention from prostatic obstruction. If the catheter is properly held in place, the bladder is constantly drained and thus put at rest. Through this catheter are practised irrigations with the solution which excites least inflammatory reaction.

The use of autogenous bacterins is sometimes a useful adjuvant, especially in subacute and chronic cases resistant to other treatment.

In the treatment of localized cystitis Geraghty states that irrigations usually suffice for the cure of lesions affecting only the mucosa and submucosa. When there is in addition mild involvement of the muscularis he has had good success by applying ten to twenty per cent. solutions of silver nitrate by means of a ureteral catheter cut off at the eye directly to the lesions, the remainder of the mucosa being protected by using saline solution as the distending medium; more obstinate lesions he has treated with the solid stick fused on the end of a catheter. In the most severe types of localized cystitis he found all treatment save excision of the affected areas or their destruction by the cautery to be useless.

If these methods of treatment do not relieve the patient and it is evident that his strength is rapidly failing from septic absorption, suprapubic or perineal drainage is indicated. When the cutting operation is forced on the surgeon in place of catheterization and irrigations, because of the pain and reaction which they excite, forcible dilatation of the prostatic urethra is a most important procedure, since this will always for a time and often permanently relieve the violent and exhausting tenesmus from which this class of patients habitually suffer.

Syphilis of the Bladder

The symptoms of syphilis of the bladder present no features characteristic of the infection. The patient's attention may be attracted to the bladder because of the discomforts usually accompanying an ordinary cystitis; or the first symptom may be a sudden painless hæmaturia. In the majority of cases there is painful, frequent micturition, acompanied at times with terminal hæmaturia of various degrees.[2]

Specific infection of the bladder is commoner in the tertiary than in the secondary stage of syphilis, and is then characterized by more pronounced distress. Few cases have been reported, possibly because many have escaped recognition.

The diagnosis of syphilitic cystitis must be based on the presence of other symptoms of the disease or a positive Wassermann, and the absence of other adequate cause. A pus-free urine is suggestive of the disease. Cystoscopic examination may reveal an intensely reddened bladder, single or multiple ulcers, or a papillomatous hyperplasia.

The treatment is that of the causal infection; local treatment is contraindicated.

[2] Baker: "Syphilis of the Bladder," *Surg., Gynec., and Obstet.*, 1917, xxiv, 187.

Perivesical Inflammation

Two forms of perivesical inflammation are described by Hallé, the cicatricial and the suppurative.

Cicatricial pericystitis is the result of chronic pelvic cellulitis, and is characterized by accumulations of sclero-adipose tissue about the base and sides of the bladder.. The perivesical tissue becomes dense and greatly thickened, and firmly mats the pelvic organs together. The masses of this tissue, by forming about the vesical insertion of the ureters, may produce occlusion of these canals.

Suppurative pericystitis appears in the form of abscesses, developing in the normal fibro-adipose tissue surrounding the bladder (Fig. 247). Usually these abscesses are secondary to prostatitis or cystitis. It is evident that they may

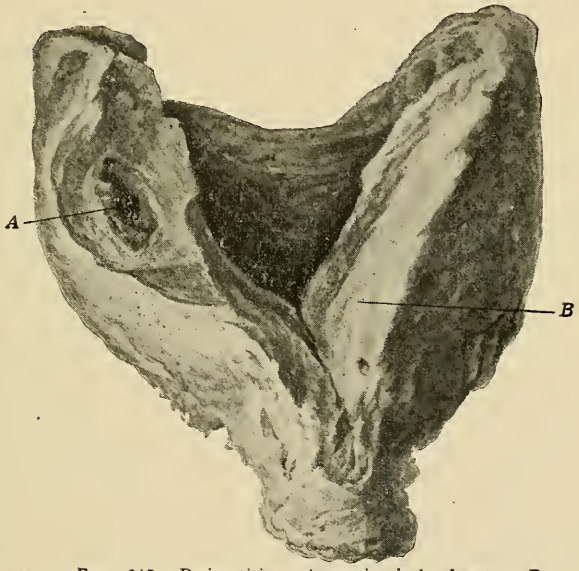


FIG. 247.—Pericystitis. *A*, perivesical abscess; *B*, greatly thickened external coats of bladder; incident to perivesical inflammation. (From Wistar Institute of Anatomy, University of Pennsylvania.)

form in cases of wounds, or ulceration of the bladder. The ulceration may be tuberculous or malignant. More commonly it is erosive, and is caused by stone or foreign body. The abscesses of parenchymatous cystitis may rupture externally and affect the perivesical tissues; usually they discharge into the bladder. Suppurative pericystitis due to stone ulcerating through the bladder-wall is localized and develops slowly. It may discharge upon the skin surface, usually in the perineum, or empty into the rectum or the peritoneal cavity.

Prevesical Abscess.—There is one form of perivesical inflammation which, from the fact that it is often primary and if promptly recognized can be successfully treated, requires special consideration; this is prevesical suppuration, or abscess in the space of Retzius.

This space is entirely external to the peritoneum, and serves in part to give the bladder room to expand and fill with urine. It is bounded anteriorly by the pubis and the anterior layer of the transversalis fascia of Cooper, behind

by the posterior layer of that fascia and by the bladder. That part of the space which extends upward beyond the pubis is limited above by the line of union of the two layers of fascia which are given off at the lower border of the sheath of the recti muscles posteriorly, and has for its lateral limits the union of these layers with the aponeurosis of the transversalis and oblique muscles. Below, the space is limited by the prostatic sheath and the superior aponeurosis of the true pelvis.

Suppuration in this region may be caused by traumatism, operative or otherwise, or by infection of neighboring organs, such as the bladder, prostate, uterus, etc. Englisch, quoted by Thorndike, classes all cases of prevesical suppuration under three headings: (1) those caused by traumatism; (2) those caused by metastasis; and (3) those caused by direct extension from neighboring organs or tissues.

It is evident from the boundaries of this space that pus may open through the anterior abdominal wall into the rectum, the bladder or urethra, the perineum, or the peritoneal cavity. A certain proportion of these cases give a tuberculous history, but proof as to the causative agency of the tubercle bacillus is wanting.

Symptoms.—The symptoms of prevesical suppuration are vesical tenesmus and irritability, pain, not sharply localized, often referred to the bowels and associated with digestive disturbances, the formation of a tumor occupying the position of a distended bladder and discoverable on suprapubic or bimanual palpation, local tenderness, and usually constitutional symptoms of suppuration.

Diagnosis.—The formation of inflammatory infiltration behind the pubis associated with symptoms of vesical irritability would in the absence of cystitis be sufficiently characteristic of prevesical inflammation. When cystitis is present the persistence of the tumor after thorough evacuation of the bladder-contents would also be pathognomonic. When the abscess points forward in the middle line, perhaps the only condition with which it is likely to be confused is post-rectus suppuration, the pus then lying behind the rectus muscle and between it and the layer of fascia which descends directly to the pubis. In this case the pus would be limited laterally by the borders of the recti muscles and would extend upward. The induration of prevesical inflammation extends laterally beyond the limits of the recti muscles, and is usually symmetrically developed in the two sides. Exceptionally the abscess extends towards one side only. We have operated on one such case where because of associated intestinal symptoms the condition was diagnosed as incarcerated hernia. Careful bimanual palpation suggested the true nature of the affection, and the presence of pus was confirmed by an incision.

Prognosis.—This is favorable, especially when the condition is properly diagnosed and treated by early evacuation of the pus. Of Englisch's thirty-three reported cases four died from a general purulent peritonitis following perforation of the abscess into the peritoneal cavity.

Treatment.—Suppuration requires evacuation and drainage. In the absence of pointing, incision should be made in the middle line directly over the pubis. Drainage should be secured by gauze packing. The same rule applies to all perivesical suppuration.

In the treatment of that form of chronic perivesical inflammation which is

characterized by the formation of masses of fibro-lipomatous tissue attention should first be directed to the cure of the condition which has produced or is keeping up pelvic cellulitis. This may be an untreated cystitis, with diverticula, or, in the case of women, endometritis and perimetritis. Hot rectal douches of normal saline solution and massage through the rectum and over the pubis may be serviceable.

TUBERCULOSIS OF THE BLADDER

Tuberculosis of the bladder is a disease of early and middle life, occurring chiefly between the ages of fifteen and forty; it has been observed, however, in children four or five years old, and Tapret noted a case occurring in a man at the extreme age of ninety-seven. It is found more frequently in males than in females, and is usually associated with tuberculosis of the kidneys, often with that of the seminal vesicles, epididymes, and prostate.

Etiology.—The predisposing causes have been found to be tuberculous nephritis, a general tuberculous tendency, often inherited, together with an infectious cystitis.

The exciting cause is infection with the tubercle bacilli. Primary tuberculosis of the urinary organs is most likely to attack the kidneys. Tuberculosis of the bladder is usually a descending one from the kidney; occasionally it is secondary to tuberculous epididymitis or vesiculitis.

Pathological Anatomy.—In well-marked cases of tuberculous inflammation of the bladder there is a pericystitis, characterized by yellow, fibrolipomatous infiltration and degeneration; the bladder-walls are thickened and rugous. The mucous membrane is ecchymotic in spots, and may be studded with miliary tubercles. Granulations can rarely be seen, but when visible they appear as fine gray dots, sometimes confluent, forming granulomata of considerable size. Ulcerations, either single or multiple, are found in the mucous membrane. Their edges are irregularly excavated, their base a greenish gray covered with thick pus. In depth they are very variable, sometimes only invading the mucous membrane, again even perforating the bladder-walls and producing perivesical abscesses, or fistulæ opening into the rectum, vagina, or hypogastrium; fistulæ, however, are rare. Microscopically, it is seen that the tuberculous granulations arise in the superficial layers of the mucous membrane, and in these lesions, which are commonly in or near the trigonum, the tubercle bacillus and many septic bacteria will be found.

Symptoms.—Vesical tuberculosis may develop so insidiously that its presence is not suspected till a urinary examination, made in the course of an examination for life insurance, for instance, shows the pus or blood. In these cases there have been no symptoms, or perhaps, when questioned, the patient will remember that he has been slightly troubled by a somewhat frequent urination, chiefly after meals and during the night. The urine is clear and limpid, is passed every hour or so, and the frequency, which in children may cause nocturnal incontinence, is aggravated by the dorsal decubitus.

Hæmaturia in many cases is an early symptom. The bleeding is slight, spontaneous, and sometimes terminal, a few drops of pure blood following the claret-colored urine. It often stops as suddenly and inexplicably as it begins,

and may not reappear for days or weeks. This symptom becomes gradually less prominent as the disease progresses. Exceptionally there may be a profuse hemorrhage, but this is less common than in the presence of vesical tumor.

Pain, when pronounced, usually denotes the onset of a mixed infection, to which the tuberculous bladder is almost inevitably doomed. The usual cause of cystitis is catheterization, but it develops spontaneously in the absence of instrumentation. Cystitis having been inaugurated, pain becomes one of the most constant, prominent, and harassing symptoms of the disease. The patient is tortured day and night by urgent desire to urinate and by violent tenesmus, sometimes recurring every few minutes; and the pain may be felt at all stages of urination. These symptoms are most pronounced when the tuberculous process attacks the region of the trigonum; when the lesions involve other parts of the bladder it may happen that an advanced stage of vesical tuberculosis will be reached before pain manifests itself.

Retention of urine occasionally results from spasm and inflammatory obstruction of the internal urethral orifice, and again true incontinence may arise from destruction of the neck of the bladder by the tuberculous process.

Pus is usually present, and if containing greatly deformed leucocytes and no microörganisms is strongly suggestive of tuberculosis. Before mixed infection the urine is limpid or at most fairly tinged with blood.

The method of staining the tubercle bacillus has been given (see p. 19). The best way of establishing its presence is by inoculation of the lower animals. Many examinations and efforts at culture are often required before the bacillus is found.

In the female a painful zone of ulcerations may sometimes be seen at the meatus urinarius, extending thence up the urethra.

The general health suffers as is the case in tuberculosis of other organs. There is loss of flesh and strength and, if mixed infection is present, there is also chronic septicæmia accompanied by fever, night-sweats, loss of appetite and often by diarrhœa. In such cases the pain is an important factor in producing deterioration of the general health.

Diagnosis.—Probably in a large majority of cases tuberculous cystitis is not suspected till the disease is well advanced and has spread wide of the bladder.

Köning states that half the patients who complain of pus and mucus in the urine as the principal symptom are tuberculous; it is certainly the case that tuberculous cystitis is by no means a rare disease.

There is no pathognomonic sign or symptom of tuberculous cystitis except discovery of the bacillus in the urine from an inflamed bladder, and sometimes the cystoscopic appearance. Tuberculosis should, however, be suspected when (1) there is a characteristic family history; (2) there have been frequent urination and hæmaturia without discoverable cause; (3) cystitis develops and persists in the absence of the ordinary predisposing and exciting causes; (4) the epididymis, cord, prostate, or seminal vesicles show signs of tuberculous involvement; (5) there are signs and symptoms of tuberculosis in other parts of the body; (6) tuberculosis is apparently the only cause which can satisfactorily account for symptoms.

The cystoscopic appearances indicative of vesical tuberculosis are: dis-

seminated or grouped tubercles; ragged, irregular, punched-out necrotic ulcers; and acutely, subacutely, or chronically inflamed areolæ surrounding tunnel-shaped or sewer-like ureteral orifices. It may happen that the appearances are not typical, as when the infiltrated rugæ simulate neoplasm, due to the formation of granulomata.

Prognosis.—This is good when other foci of the disease can be removed; otherwise the condition is practically hopeless. With the removal of the primary focus, as a tuberculous kidney, the bladder commonly proceeds to spontaneous cure; when this does not occur persistent treatment usually brings about the desired result. When the primary focus cannot be eradicated, either by surgical or other therapeutic measures, treatment directed to the bladder infection is to be regarded as merely a palliative procedure. Under these circumstances the bladder inflammation and symptoms usually become progressively worse, till death from the original focus of disease or from some intercurrent condition comes as a welcome relief from suffering.

Treatment.—Since vesical tuberculosis is nearly always secondary, the first thought in treatment should be to discover the source of the disease; and, as this is in one or both kidneys in a very large percentage of cases, a renal origin is always to be suspected. When nephrectomy is a permissible operation, it is our most potent means in the treatment of vesical tuberculosis.

When the primary focus cannot be removed for any reason, and when the vesical condition fails to mend with the desired celerity after such removal, certain measures are applicable with the idea of ameliorating the symptoms or hastening the cure of the condition. In the performance of all manipulations wherein the bladder is entered by instruments, the greatest care must be exercised to prevent the infection of the bladder with additional organisms.

It is important to get the patient in the best possible condition, to make use of the beneficial effects of sunlight and fresh air, and usually to employ tuberculin therapy for the purpose of increasing the individual's specific resistance to the tubercle bacillus.

Local treatment of the bladder must be conducted with extreme caution. Irrigations are not well borne as a rule, and should rarely be employed. Particularly is silver nitrate contra-indicated in tuberculous disease of the bladder.

The best results are obtained by posterior urethral instillations of bichloride of mercury and of phenol. The former of these is used in dilutions of from 1: 20,000 to 1: 500, while the latter is applicable in strengths of 1: 200 to 1: 20. From five to twenty minims may be instilled. The strength of the solution should be such that the pain produced is of an easily bearable degree, and is proportionately less than the relief obtained as a result of the treatment; the stronger solutions mentioned should be used only after a long gradual approach.

Other substances which may be used are iodoform emulsion (10 per cent. in oil), gomenol oil (25 per cent. in oil), and thallin sulphate (3 to 20 per cent.).

The frequency of the application of any of these substances should be such that all reaction from one treatment shall have disappeared before the next is administered; the usual interval is two, three, or four days.

When the pain in the bladder is severe, resort must be had to anodynes.

A favorite way of administering these is by the rectum, either by suppositories (extract opii gr. ½ to i, combined with ext. bellad. gr. ¼, or ext. hyoscyami gr. ½ to i), or by means of a syringe fifteen to thirty grains of antipyrine and ten to twenty minims of laudanum dissolved in one-half ounce of water may be injected.

Operation is indicated when the pain and urgency become unbearable and are not controllable by safe doses of narcotics. Under these circumstances there will often be infiltration of the prostate and seminal vesicles: hence complete eradication of the disease will be no longer practicable. The operation is then performed as a measure of relief and not as one of cure, the bladder being drained through either a perineal or a suprapubic opening. Often this drainage gives immediate and complete relief. Sometimes pain and tenesmus persist. The suprapubic cystotomy is to be preferred, since the bladder is more liable to be opened at a point somewhat removed from the most active region of the tuberculous process. A perineal wound is very apt to become infected, whereby troublesome fistulæ are formed.

The suprapubic operation also possesses the advantage of allowing the surgeon to inspect the interior of the bladder and to treat directly intravesical lesions. These may be thoroughly curetted and well rubbed with iodoform, or may be destroyed by the application of the actual cautery or the high frequency current. Following these procedures there are some reported cures. Were tuberculosis more often confined to the bladder, this form of intervention would promise brilliant results.

Having opened and drained the bladder above the pubis and destroyed or removed tuberculous ulcers, the vesical mucosa is kept as clean as possible by irrigations with normal salt solution or a weak antiseptic, provided it does not excite too much reaction. Sometimes as a result of this treatment cystitis is cured and the tuberculous process appears to be checked, the suprapubic opening closing on removal of the drainage-tube. There is, however, a constant risk that the abdominal wound may reopen and an abdominal hernia be the outcome. In unfavorable cases the tract of the drainage-tube often becomes tuberculous.

CHAPTER XXIII

SURGERY OF THE BLADDER (Continued)

CALCULI AND FOREIGN BODIES

CALCULUS

A VESICAL CALCULUS is a concretion of the solid urinary constituents lying in the bladder. It becomes a surgical problem when it is of such size or so placed that it does not escape through the normal passages. Calculi may be formed in the bladder, or may have their origin in the kidneys.

Calculi may be generally grouped under the following headings:

1. Those formed from the normal constituents of the urine,—the uric acid, the phosphatic, the mixed, and the urate calculi.

2. Calculi formed of salts found in normal urine, but never present in excess except in disease,—the oxalates and carbonates.

3. Concretions formed from elements entirely foreign to normal urine,—cystin, indigo, and xanthic oxide.

The large majority of stones are formed of uric acid and the urates; the phosphatic and mixed calculi come next in order of frequency; and last come the oxalates and rarer forms,—indigo, xanthic oxide, etc.

Uric acid calculi (Fig. 248, A), formed in the kidney pelvis, descend through the ureter to the bladder, usually causing that form of violent and paroxysmal pain which is termed renal colic. Once in the bladder their further growth is due to accretion of uric acid alone, or they may form nuclei for the deposition of other elements. (Fig. 248, E.) Uric acid calculi are generally smooth, spheroidal, moderately hard, and yellow to reddish brown in color.

High living and a gouty diathesis are factors predisposing to the formation of these concretions. They occur at the extremes of life.

Urate Calculi.—Sodium, potassium, and ammonium urates, though rarely forming large stones, are constantly and copiously deposited as sediment in febrile affections, and when from any cause the urine becomes markedly concentrated. Urate calculi are observed almost exclusively in children. In the adult they may form the nuclei of large concretions made up of divers elements. They are grayish yellow in color. (Fig. 248, H.)

Phosphatic calculi follow the uric acid and urate concretions in order of frequency; there are three varieties.

1. The amorphous calcium phosphate rarely forms a calculus of itself. It is commonly deposited in layers about calculi of other salts, or is intermingled with them, sometimes reaching considerable size. It crumbles easily; its color is a dirty brown or white (Fig. 248, B).

2. The triple phosphates (ammonio-magnesium phosphates) are commoner in calculus formation than calcium phosphate. Such calculi are crystalline and of a whitish color. Formed in ammoniacal urine only, they are vesical in origin and frequently complicate cystitis.

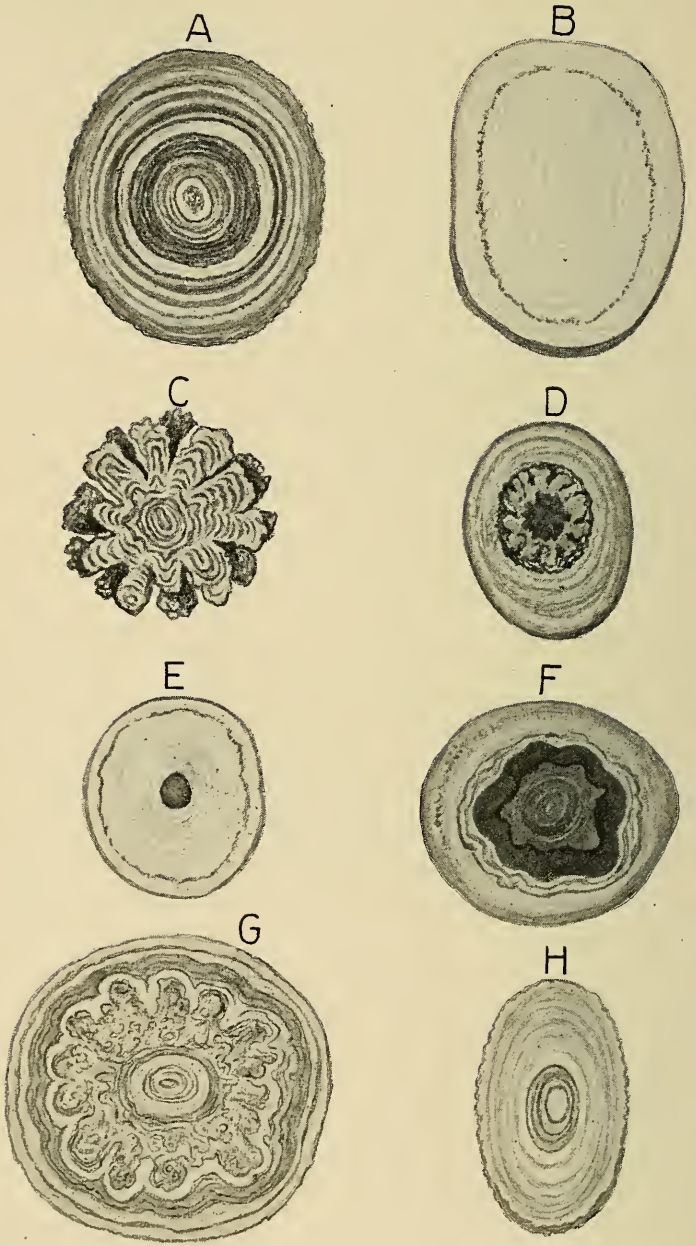


FIG. 248.—Vesical calculi. A, uric acid; B, phosphate; C and F, oxalate stone with phosphatic incrustations; D, cystin; E, uric acid with phosphatic incrustation; G, mixed stone, chiefly uric acid and phosphates; H, urate.

3. Mixed fusible calculi, being composed of the triple phosphates and calcium phosphate, are not uniform throughout; they form about a nucleus of calcium oxalate, uric acid, foreign bodies, etc. (Fig. 248, G). They appear as masses which resemble white friable mortar, and are formed in ammoniacal urine.

Calcium oxalate calculi, like those of uric acid, are of renal origin, and occur most frequently in patients suffering from oxaluria, a diathesis associated with indigestion and neurasthenia. These are the hardest of all stones, and are usually small or of medium size, spheroidal in shape, dark brown or black in color, and have a tuberculated surface, giving rise to the name of mulberry calculus (Fig. 249). Amorphous urates and phosphates are often deposited between the tuberculations (Fig. 248, C), or may entirely encase the oxalate (Fig. 248, F).

Calcium carbonate calculi are rare. When found they have been multiple, small, weighing from thirty to forty grains each, and hard and lamellar in structure, similar to the calcium oxalate calculi.

Cystin Calculi.—Cystin as a major constituent of calculus is extremely rare. As is the case with the uric acid and calcium oxalate calculi, cystin concretions originate in the kidney. In appearance they are irregular and knotty, sections showing no attempt at crystallization, waxy and yellowish white at first, but turning to green after long exposure to the air (Fig. 248, D).

FIG. 249.—Mulberry calculus. (From the German Hospital, Philadelphia.)

Xanthin is another rare constituent of calculus. Indigo does not form a calculus in itself, but may be so important an ingredient that it gives the stone its typical color. It occurs in cases of liver disease associated with cystitis.

A calculus is named from its preponderating element, but usually there is found one salt serving as a nucleus, with layers of different salts superimposed. Thus, the phosphatic calculus is often found to have in its centre a minute concretion of calcium oxalate or uric acid. On dissolving out the salts of even the smallest calculus there will be found an albuminoid or colloid framework upon which these have crystallized, and which serves to agglutinate the mass. Rainey and Ord have demonstrated the tendency of crystalline salts when in solution with colloid or albuminoid substances to assume rounded or spheroidal forms in crystallization. It is certain that the development of stone is not wholly due to the mere presence of an excess of any of the urinary salts, for copious deposits of uric acid and the phosphates may exist for years without any evidence of calculus formation.

If, however, at a time when the urinary salts are in excess, any renal or vesical irritation is lighted up, by means of which blood and serum are intermingled with the urine, furnishing an albuminoid substance which favors the agglutination of the small crystals, calculi may form, and, once formed, tend to increase in size.

Vesical calculi, when free, are usually spheroidal. They may be irregular or faceted from multiplicity and erosion, or from having been moulded in a

diverticulum or in the prostatic urethra. Ord holds that calculi split spontaneously because, incident to changes in the specific gravity of the urine, the colloid framework becomes swollen by absorption of a liquid of different density, and the concretions fracture along the lines of deposition upon this framework.

Etiology.—It is evident that for calculi to form two main factors are requisite: first, a diathetic tendency to over-elimination of the urinary solids which form the basis of calculi; and, second, local conditions which cause these solids to conglomerate.

The diathetic tendency is strongly marked in certain localities, but these are so widespread, so totally different in climate and surroundings, and the diet and habits of the people so differ, that no general law can be deduced which bears on calculus formation.

There is a popular belief that a limestone soil which furnishes hard drinking-water predisposes to calculus; but, although the disease is quite common in many limestone districts, it is equally common in sandstone districts; moreover, there is no reason why the ingestion of lime should cause uric acid deposits. Vesical calculi are found in cold as well as in warm countries; for instance, in Southern China and in Northern Scotland. They are more frequent in the central United States than in New England and the Southern States, and one section of a single State may furnish more cases than another.

Urinary calculi are found from extreme youth, even in the fœtal bladder, to old age.

In the statistics of Civiale, Coulson, and Thompson, compiled from 10,467 cases, 62.33 per cent. occurred in persons under twenty years of age; these cases were taken from hospital patients representing the poorer classes. Sir Henry Thompson, in a series of private cases numbering 798, operated for vesical calculus 93 times in patients between the ages of sixteen and fifty years; 527 times in patients ranging between fifty and seventy; 175 times in patients over seventy; and but 3 times in patients under sixteen.

He believes that calculi are so frequently found in hospital and charity practice in patients under twenty years of age because of the bad hygienic surroundings, irregular diet, and malnutrition of children in the lower walks of life.

He accounts for more than sixty-six per cent. of his private calculus patients being over fifty years of age on the ground that the upper and middle classes of society are predisposed to the uric acid diathesis after the age of fifty, because then vital activity diminishes, and the desire for rest and a sedentary life are indulged, without commensurate lessening of the quantity and quality of food ingested. It would therefore seem that insufficient clothing, lack of proper nourishment, and improper hygienic surroundings among children predispose to calculus formation, while among adults the same effect is produced by conditions of a very different character.

The relative difference in the length and dilatability of the male and the female urethra probably explains the greater frequency of calculus in men. A small uric acid stone reaching the female bladder has little tendency to linger there, the short, wide urethra allowing it to pass without producing even a sensation of uneasiness. The vesical calculi observed in women are usually

incrustations about a foreign body. The proportion of calculi found in the female bladder as compared to the male bladder is about one to twenty-two.

Symptoms.—Preceding the formation of a stone there may be a history of gravel, of oxaluria, of heavy deposits of urates. When the stone is of uric acid and is formed in the kidney, lumbar pains, hæmaturia, and renal colic often precede its arrival in the bladder; it may, however, reach this viscus without exciting the slightest symptom.

Having reached the bladder, the stone acts as a sterile foreign body, producing irritation and congestion, and thus favoring the development of cystitis. Frequent micturition, pain, hæmaturia, and reflex disturbances are the prominent symptoms.

Frequent Urination.—This symptom is most marked in the day-time: it is aggravated by motion, and relieved by rest. The desire to urinate comes suddenly and is almost irresistible. The patient may be compelled to urinate every two or three hours, or in some cases every few minutes. The act of urination is often accompanied by much tenesmus, in which the rectum participates, so that prolapse of the bowel, particularly in children, is by no means uncommon. A small stone irregular in shape produces a more aggravated condition of frequent urination than a large, smooth calculus. An encysted or adherent stone, or one which lies at the base of a bladder so changed in shape that the calculus is not liable to come in contact with the vesical neck, often gives rise to no marked frequency of urination. It is to be noted that frequent urination is a symptom of so many other bladder conditions that in itself it does not necessarily suggest the presence of stone.

Exceptionally there is sudden stoppage during the passage of a full-sized stream. This is observed chiefly in young persons and in patients having small stones, since it is due to the dropping forward of the calculus into the vesical orifice of the urethra. It is extremely suggestive of calculus if it can be obviated by the patient urinating in certain positions, as, for instance, when lying on the back. As with frequent micturition, sudden interruption of the stream is a symptom of inflammatory troubles of the vesical neck, and is not pathognomonic of stone.

Pain.—The pain of vesical calculus is usually referred to the lower urethral surface, about an inch posterior to the glans. It is burning and stinging in character, and is less pronounced in old men than in children, prostatic enlargement in the former preventing the calculus from coming in contact with the vesical neck.

Pain is most marked at the end of urination, because then the inflamed mucous membrane is brought in direct contact with the stone. The intensity of pain varies proportionately to the degree of cystitis and the size and nature of the stone, and is intensified by jarring motions and by change in position. Small stones, especially if they be rough, cause more suffering than do large ones. A history of pain pronounced during the early stages of stone, and gradually lessening, suggests that a small rough stone has become covered with mucus or with phosphatic deposits, thus forming a smooth surface. A stone may be carried for years without exciting the slightest pain.

Hæmaturia is of importance only when associated with other symptoms. It is caused by the mechanical friction and scratching of the calculus, and is most pronounced when the bladder is congested, as in cystitis. It is markedly aggravated by motion. The blood is most apt to be voided towards the close of urination.

Reflex Disturbances.—Priapism has been noted as a reflex, particularly in children; in them it may lead to the practice of masturbation, since pain is referred to the end of the penis, and there is commonly pulling and handling of that organ in instinctive efforts to obtain relief. Reflex pains felt in the rectum, the perineum, the hypogastric region, the small of the back, on the outer surface of the thighs, the lower leg, or the foot, are frequently noted.

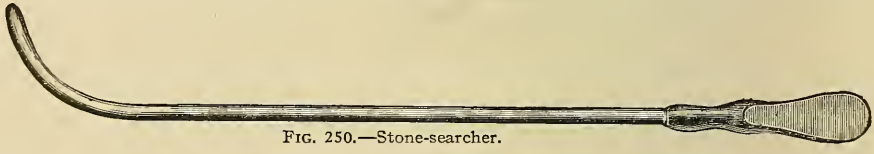


Fig. 250.—Stone-searcher.

There is a peculiar pain in the foot, known as podalgia, which is sometimes symptomatic of stone; it is frequently located in the neighborhood of the ball of the great toe, but may extend over the whole sole. It is most commonly observed in the gouty and rheumatic. It disappears as soon as the calculus is removed. Pain may also be felt in the upper extremities of the lungs.

Rectal prolapse, hemorrhoids, and subconjunctival hemorrhage, though not absolute in their significance, may aid in diagnosis, since they are symptomatic of the violent straining efforts which frequently accompany the act of urination.

True inflammation of the bladder is likely to occur sooner or later, though some cases of stone may last indefinitely without this complication. It is usually caused by instrumentation; but the intervention of this agency is not necessary for its development. It aggravates the symptoms already given, and causes a heavy deposit of mucopus in the urine.

Diagnosis.—The diagnosis of stone is founded upon physical examination.

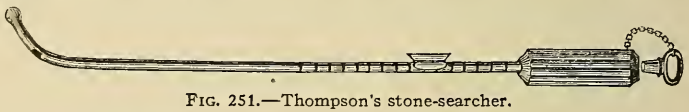


Fig. 251.—Thompson's stone-searcher.

The symptoms above described, either singly or altogether, may be excited by any inflammation or irritation at the neck of the bladder independent of its cause. Pain referred to the under surface of the glans penis and felt most acutely at the end of urination, sudden interruption of the full stream, relieved by change of posture and not occurring when certain postures are assumed, and hæmaturia, can be considered only as strongly suggestive of stone and as calling for direct examination.

A vesical calculus may excite no symptoms. Morris records the case of a man who, at the age of sixty-six, learned through an attack of hæmaturia that he had vesical calculus. This patient died, after thirteen years, of carbuncle of the neck. He never again had a bladder-symptom, although he never submitted to operation.

The examination is conducted (1) by bimanual palpation; (2) by radiography; (3) by cystoscopy, or, if this be unavailable, by means of a stone-searcher or sound, or an evacuator attached to an aspirator.

1. Bimanual palpation is thus practised in the male: the patient having passed his water is directed to lean well forward over a chair, with the legs moderately separated and the abdominal muscles relaxed. The surgeon then introduces the forefinger of the right hand into the rectum and with the fingers of the left hand presses upward and backward, directly over the pubis, towards the base of the bladder. In place of standing, the patient may lie on his back, the head and shoulders elevated, the thighs flexed; the hands of the surgeon

FIG. 252.—Large vesical calculus. (Skiagraph made by Dr. H. K. Pancoast.)

are used as just described. In thin subjects and in those with not too muscular abdominal walls, the presence or absence of calculus of even small size can sometimes be thus determined.

In the female examination is made through the vagina, the bladder being palpated by the ordinary bimanual manipulation.

2. X-ray examination, when available, represents the least traumatizing method of establishing the diagnosis, and is usually certain in its findings (Figs. 252 and 253).

3. Instrumental exploration is inaugurated by passing a cystoscope. When the conditions are favorable for the use of this instrument, this implying an experienced operator, further diagnostic examination is not needed. When

a cystoscopist is not available, or bladder conditions negative the use of the instrument, the stone-searcher is serviceable. This instrument should have a straight shaft fully ten inches long, and a short curve near the tip. Two instruments should be provided, one with a very slight curve, the other with an abrupt curve, permitting it to be carried into the pouch behind the prostate. The calibre should be about 13 F. (Fig. 250). It is desirable to begin the examination with the bladder fully distended, and to allow the urine gradually to escape as the search is continued. For this reason, and because it allows of an approximate estimation of the size of the stone, Thompson's stone-

Fig. 253.—Calculi of bladder and ureter. Skiagraphy demonstrated apparently two vesical calculi. Cystoscope showed that the smaller one only was intravesical, the larger stone lying in the pelvic end of the ureter. (Skiagram by Dr. H. K. Pancoast.)

searcher is particularly serviceable (Fig. 251). The solid steel sounds shaped as already described, and provided with flat handles, are the instruments of choice.

These sounds are passed with the patient in a recumbent or semi-recumbent position, with shoulders raised and thighs flexed and separated. Should cystitis not be present it is particularly important to conduct all manipulations in accordance with the rules already laid down for aseptic instrumentation of the urethra and the bladder, since it is now universally recognized that the passage of instruments is the usual cause of bladder-infection. The instrument, having been sterilized and lubricated, is introduced without difficulty if the operator

remembers that its curve does not correspond with the fixed curve of the normal urethra; at the time the extremity of the instrument traverses this region downward pressure must be made with the fingers on each side of the penis, to straighten out the urethral curve. Even after the sound has traversed the membranous urethra it is often arrested at the internal vesical sphincter, and when in this position a comparatively roomy prostatic urethra may allow of some degree of lateral motion. It is important to remember that the sound is not satisfactorily introduced into the adult bladder unless at least eight inches of the straight shaft have been passed, and that when it has properly entered it can be easily rotated almost, if not quite, around its long axis.

The bladder having been entered, the cavity of this viscus should be systematically explored. The sound is partly withdrawn and pushed back again with comparatively rapid motions, the handle being elevated and depressed. The withdrawal is at no time sufficient to engage the curve of the instrument in the prostatic urethra. The back of the sound should then be turned towards one side of the bladder, and the point, directed towards the opposite side, should be made to traverse the arc of a circle, sweeping transversely through the bladder from above downward. This motion, begun with the inner end of the sound at the bas-fond, is continued while the sound is gently drawn outward until the curve reaches the vesical neck. It is then pushed in again until the posterior wall of the bladder is touched. The point is now turned to the opposite side and the same manœuvre is repeated. If the stone is not found in this manner, the searcher is again introduced to its full length, and the tip is turned gently towards the floor of the bladder and rotated quickly from side to side, while the instrument is gradually withdrawn until its curve catches the vesical neck. The anterior wall of the bladder may be explored by pressing it down by suprapubic pressure till the tip of the instrument can reach its surface. Where there is an enlarged prostate and the base of the bladder is depressed, it is well to elevate this portion of the viscus by a finger introduced into the rectum, while the exploration with the sound is continued.

If these manipulations fail to detect the stone, the urine should be gradually withdrawn, and as the bladder contracts they should be repeated. Thompson's searcher should be used under such circumstances.

The presence of stone is denoted by a distinct click, which can be both felt and heard. The feeling is that of a sound coming in contact with a hard body, the click like that of a piece of metal striking the sound. It is important to bear in mind that this click should be heard and not merely felt. The attachment of sounding-boards or of tubes to the searcher is of no practical help to the surgeon himself, though both are useful for class demonstration. Suprapubic auscultation is said to be helpful.

The size of the stone may be estimated by a searcher provided with markings on its shaft and with a sliding collar (Fig. 251). By passing this collar to the meatus after the stone is first touched, and then marking the point at which the sound ceases to come in contact with it as it is slowly withdrawn, the diameter of the stone may be determined, this being, of course, the distance between the collar and the meatus.

The surgeon may either fail to detect a stone which is present or imagine

he has detected a stone which is not present. Failure to detect a stone which is present may be due to—1, the more or less encysted condition of the calculus, leaving little or none of its surface exposed; 2, the presence of a diverticulum with a very small opening containing the stone; 3, the fixation of the stone to the summit or the anterior wall of the bladder by adhesions; 4, the covering of the stone with lymph or blood-clot; 5, the lodgement of the stone in a deep post-prostatic sinus or between the lateral or upper walls of a prostatic overgrowth and the vesical mucosa; 6, failure to enter the bladder with the sound, the prostatic urethra being dilated and the vesical orifice of this canal being obstructed by prostatic overgrowth.

The surgeon may believe that he has detected stone when none is present from—(1) incrustation of a tumor with lime salts; (2) a trabeculated condition of the bladder, especially when associated with ulceration and partial incrustation; (3) bony growths developed from the pelvis; tumors, fæcal impaction in the rectum; and undue prominence of the promontory of the sacrum.

Examination by the lithotrite is of advantage in enabling the surgeon to determine the exact size of the stone, to ascertain whether or not it is adherent, and to make a rough estimate of its hardness. As a means of simply detecting the stone it is no more serviceable than a stone-searcher of similar curve, and is more difficult of manipulation.

The evacuating-tube attached to an evacuator is probably the best stone-searcher if the calculus is very small and moves freely in the bladder. As the liquid in the evacuator is driven forcibly in and then aspirated, the small calculus will be brought against the opening of the catheter with a sharp and unmistakable click. It should be noted that if the eye of the tube is carried too near the vesical wall this will be sucked in and will give a jarring sensation, or if the joints of the instrument are loose there may be produced a sound which will closely simulate the click of a stone. This instrument is useless when the stone is encysted or adherent.

An examination with a cystoscope is of service as a means of finding stones which cannot be reached by the sound, corroborating diagnosis, determining whether a stone is adherent or encysted, and discovering the conditon of the vesical mucosa.

Prognosis.—A vesical calculus may, in the absence of cystitis, from the frequency and difficulty of micturition, cause hypertrophy and thickening of the bladder-walls, dilatation of the ureters and kidney pelves, and a chronic congestion of the whole urinary tract, strongly favoring infection. Cystitis once started is constantly aggravated, and may extend deeply. Exceptionally the calculus ulcerates through the vesical walls, forming a pericystic abscess (Fig. 254).

From constant engorgement the prostate slowly enlarges, and, by obstructing the outflow of the urine, favors retention, with reflux of septic fluid into the ureters and kidney pelves, and consequent pyelonephritis. Hence the prognosis of untreated calculus is grave.

Prophylaxis.—The presence of gravel in the urine, or other evidence of supersaturation with solids, such, for instance, as heavy deposits, should lead to such hygienic and dietetic regulations as would naturally tend to lessen the

specific gravity of the urine passed. Of prime importance is the careful regulation of digestion by appropriate diet.

Systematic exercise should be prescribed, and the bowels kept fairly soluble, preferably by salines administered in the morning on rising and at night just before retiring. This latter time is particularly one of choice in the case of an alkaline mineral water, because the urine naturally becomes most acid during the small hours of the morning. Supersaturation of the urine is avoided by diluting it with water or bland liquids. These must not be taken in sufficient quantity to cause indigestion. Since salt renders uric acid more soluble, it is well to use this liberally with food.

The most efficient prophylaxis is based on keeping the bladder free from infection (*i.e.,* remedying all conditions which cause straining micturition or residual urine), and in curing, usually by efficient drainage, infection when it has developed.

Following renal colic, the surgeon should make certain, usually by the absence of vesical symptoms, that the calculus has passed out of the bladder; or if it has not, and probably cannot do so because of an obstructive lesion,

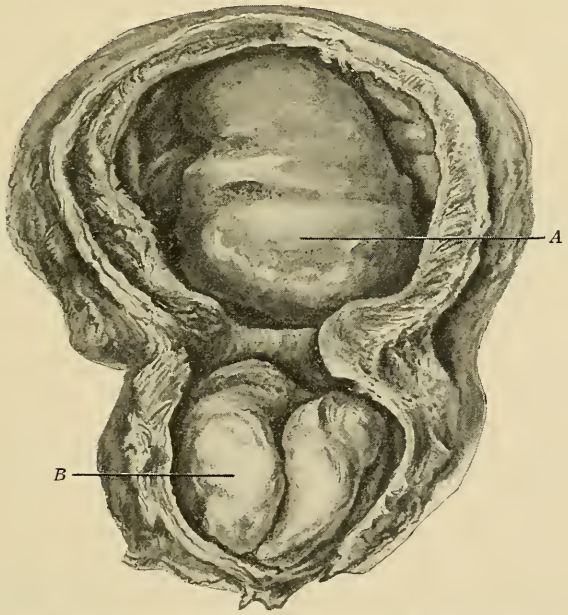


Fig. 254.—Vesical calculi. *A*, large stone almost filling main cavity of bladder; *B*, stone lying within infected pouch. (No. 69-5-7. From Museum of Pathology, University of Pennsylvania.)

should remedy this by means of Young's punch or other suitable instrument at the time of the removal of the calculus.

Alkaline urine will slowly dissolve pure uric acid: hence when for any reason operation is inadvisable, it would seem worth while to render an acid urine alkaline by the administration of full doses of potassium citrate, this drug being eliminated as the carbonate. There is no instance of a uric acid stone having

been perceptibly reduced in size by this treatment. When the urine shows excessive phosphates, a tonic treatment, together with the use of acid sodium phosphate (one or two drachms a day), or nitrohydrochloric acid, is indicated.

TREATMENT OF VESICAL CALCULUS

Stones, if small, may be removed under guidance of the eye with Young's cystoscopic rongeur, or occasionally may be washed out through the sheath of a cystoscope, or with a Bigelow's evacuator. If movable, accessible, and not too large and hard, stones may be crushed and washed out (litholapaxy). Or removal may be effected through a suprapubic or perineal opening. Whatever method be chosen, a preliminary treatment of a clinically infected bladder is indicated, usually best applied by the continuous catheter and mild antiseptic flushings through it. Nor is it advisable to operate during the exacerbation of the chronic pyelonephritis (see p. 633) from which the prostatic stone case so frequently suffers. The internal administration of urinary antiseptics for one day preceding operation and two days afterward is desirable.

Litholapaxy

The conditions which indicate the operation are a stone small enough to be seized in the jaws of the lithotrite (2 inches), fragile enough to be broken by

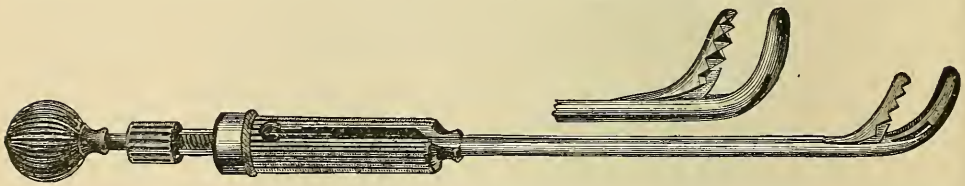


FIG. 255.—Bigelow's lithotrite.

it (practically all stones not more than an inch in diameter), and so placed that the manipulator can readily grasp it and afterwards the large fragments which result from the first breaking. Moreover, the urethra must admit without

FIG. 256.—Weiss's lithotrite.

undue trauma at least a 32 instrument if the patient be an adult, a 22 if he be a child.

The crushing instrument, or lithotrite, devised and perfected by Bigelow (Fig. 255), is the one commonly employed, and perhaps is more satisfactory than any of the many modifications since suggested (Fig. 256).

The instrument contains a male and a female blade, so arranged that they can be separated or approximated by a sliding motion. As soon as the calculus

is grasped the blades are locked by a turn of the collar of the handle; this turn at the same time brings a powerful screw in proper relation with a set of threads, so that on turning the knob of the extremity of the handle the male blade is forced downward and thus crushes the stone. Especial attention is devoted to the construction of the jaws and teeth; these are so made that clogging by the lodgement of masses of crushed calculi is impossible. Instruments made with wide fenestræ passing completely through the female blade may have fragments jam so firmly that to remove the instrument without laceration of the urethra suprapubic cystotomy may be required. The male blade—*i.e.*, the sliding one—has blunt, pyramidal projections on the jaw, so that the cusps alone catch the calculus. As the latter is broken the fragments are shed to the sides, instead of being jammed against the female blade. The latter is fenestrated only at its base, to receive a spur on the base of the male blade, thus preventing the clogging of its heel by small fragments (Fig. 257). The tip of the female blade is slightly prolonged and curved back, thus allowing it to slide readily into the urethra, and also lessening the danger of penetrating the vesical mucosa as the blades are brought together.

This instrument is powerful, does not jam, is simple in construction, and

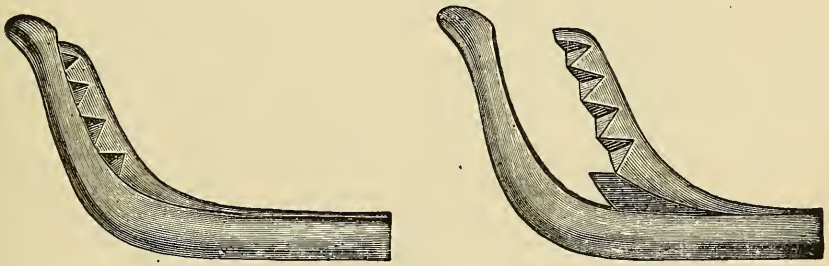


Fig. 257.—Jaws of Bigelow's lithotrite.

enables the operator to search for the calculus, grasp it and crush it without taking his hands from the handle.

The evacuating instruments are full-sized catheters, straight, or with a very slight curve, at the end, provided with eyes fully as large as the calibre of the tube, and an aspirating apparatus, which consists of a thick rubber bulb with a wide-mouthed glass receiver attached below and an opening and stopcock above, so that it can be completely filled with water (Fig. 258). It has a double stopcock on the side, the latter fitting to the catheters externally, and internally connecting with a fenestrated tube, which penetrates one or more inches into the bulb. The aggregate emptying power of these fenestræ is greater than the open end of the tube, so that in forcing water into the bladder it rushes in through these small lateral holes with greater velocity than through the large opening at the end. Thus there is little danger that fragments will be drawn up into this tube from the receiver and driven back against the walls of the bladder.

Operation.—Litholapaxy may be performed under local anæsthesia, but as a rule the use of a general narcotic is preferable, and this should be given to the extent of abolishing the bladder reflex and securing muscular relaxation.

The urine is drawn, and the bladder is irrigated with an antiseptic, either silver 1 to 5000 or a sterile saturated solution of boric acid; six ounces of boric acid solution are then injected, preferably through the evacuator which the surgeon intends to use, as it is then certain that the urethral calibre will admit it. The patient should lie upon his back, the shoulders being raised, and the thighs well separated and slightly flexed; the posture used for cystoscopy is suitable (see p. 42). The lithotrite is introduced exactly as a sound is passed, the surgeon standing at the patient's left. It must be remembered that the weight of the lithotrite and its long shaft place a powerful lever in the hands of the surgeon, which, if used improperly, may cause urethral rupture. When the beak of the instrument has entered the bladder, the handle will lie between the thighs. The surgeon then passes to the patient's right and manipulates the instrument from that side. The beak should be gently pushed onward until it touches the

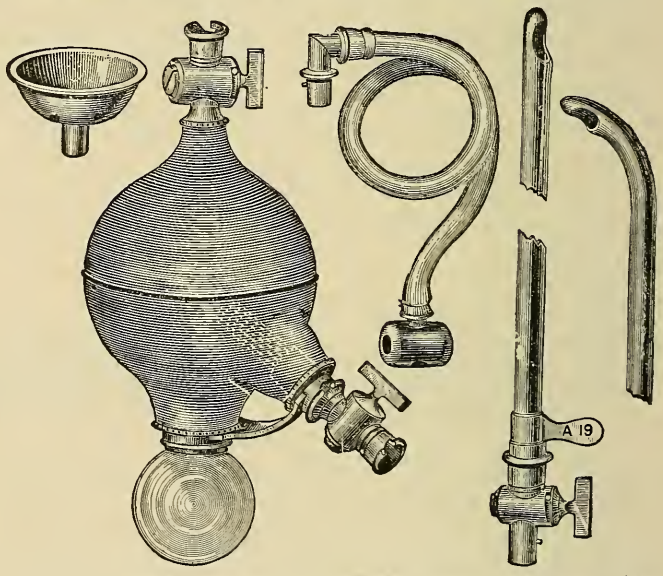


FIG. 258.—Bigelow's evacuator and tubes, with metal cup and soft-rubber tube for filling.

superior wall of the bladder, when the blades are separated until the male blade touches the neck of the bladder; they are then closed rapidly. If the calculus is caught, it should be fixed by a turn of the collar and then crushed by turning the screw-handle. If the calculus is not caught in the first manœuvre, the beak of the instrument should be gently turned from one side to the other, alternately opening and closing the jaws (Fig. 259). If it still eludes the grasp, the lithotrite should be turned with the beak directly downward, thus exploring the region behind the prostate.

Whenever the calculus is grasped it should be firmly fixed by a half-turn of the handle, and the instrument should then be turned so that its beak points upward, and be withdrawn so that the stone will be, as nearly as can be guessed, in the centre of the bladder. By this manipulation the operator can assure himself that he has not grasped a portion of the mucous membrane, and can

proceed to crush the stone by rapidly screwing down the handle (Figs. 260 and 261). These manœuvres are repeated until the stone is reduced to small fragments. Were the operation to terminate here, as was at one time advised, it would be lithotrity, the older method being to allow patients to evacuate

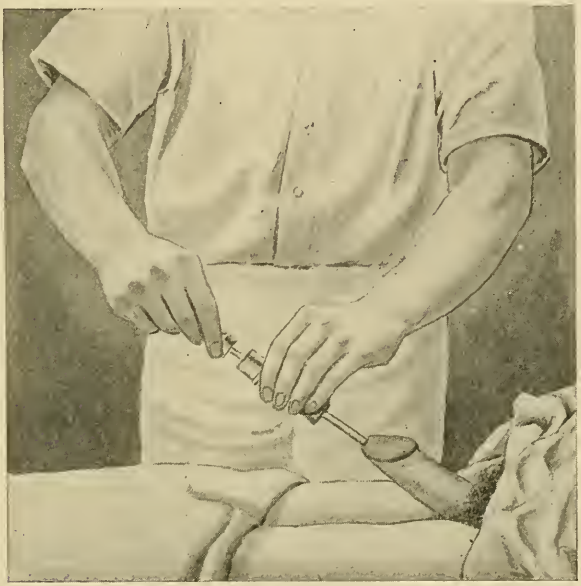


FIG. 259.—Opening and closing the blades of the instrument while searching for and grasping the calculus.

FIG. 260.—Crushing a small, soft calculus.

by natural efforts the fragments of stone thus crushed. This is, however, undesirable, for obvious reasons.

The tightly closed lithotrite having been withdrawn, an evacuating catheter of as large a size as can be introduced through the urethra is passed. The extremity of this instrument being kept well against the urethral roof, when it reaches the membranous portion of this canal its outer extremity is carried

FIG. 261.—Crushing a large, hard stone.

FIG. 262.—Evacuating fragments after the calculus has been crushed.

downward, pressure being exerted at the same time at the root of the penis by the index and middle finger of the left hand placed on either side of this organ, thus relaxing the suspensory ligament and straightening out the urethra. This manœuvre is especially useful when, as in this instance, it is necessary to pass an instrument the curve of which is less than the fixed curve of the urethra.

The evacuating bulb, filled with warm boric acid solution or sterile water, is then connected with the catheter, the stopcocks between the two are turned on, the bubbles of air contained in the catheter are allowed to rise to the top of the bulb and are squeezed out, the stopcock there being turned on for a moment, and then, by gentle slow pressure, about half the fluid in the bulb is allowed to pass through the catheter into the bladder. After waiting a few seconds for the fragments to settle about the base of the bladder, the pressure on the rubber bulb is suddenly relaxed, and thus the fragments are sucked up into the glass receiver (Fig. 262). This process of alternately distending the bladder and sucking out the fluid is continued, the catheter being carried in different directions, until no more fragments escape. This may be determined by auscultation over the bladder during the process of aspiration, any fragments which remain being heard to click against the evacuating catheter. The catheter should then be withdrawn, a stone-searcher or cystoscope introduced, and careful search made for any remaining calculus; none being found, the operation has been completed.

In place of the aspirating instrument used by Bigelow, it is worthy of note that if the fragment is thoroughly pulverized the natural expulsive force of the bladder is sufficient entirely to evacuate the fragments. This may be accomplished by introducing a full-sized catheter, distending the bladder by a gravity-bag or syringe, then allowing the contents to flow away in a full-sized stream. It is obvious, however, that this method of evacuation is not so sure as that provided by the Bigelow apparatus.

The only serious complication liable to occur during the course of litholapaxy is the clogging of the blades. This should be obviated by rapping them sharply and quickly together several times. If this manœuvre fails, the tip of the instrument should be brought up against the pubis and suprapubic cystotomy performed. In case the bladder should be ruptured, immediate suprapubic cystotomy and drainage would be indicated.

The further treatment is so directed that the patient is kept quiet in bed on a restricted diet for two days to a week, or until pus and blood disappear from the urine. During this time hexamethylenamine or salol is given by the mouth and the bowels are kept open by enemata.

Guyon warmly commends the retained catheter as an after-treatment of litholapaxy, keeping it in place for twenty-four hours. Many of his cases had been infected for a long time, and were old prostatics with phosphatic calculi, the class in whom vesical operation is likely to result fatally. His results were most favorable, and seemed to indicate that the retained catheter distinctly lessens mortality in infected prostatics with vesical calculi.

Chismore describes a modification of the Bigelow operation employed by him in fifty-two cases. His patients were all old, and many of them were prostatics. He had no deaths. He believes that his method is particularly ap-

plicable to cases of senile atrophy with pouched or irregular bladder. These conditions, together with the consequent alterations of the vesical orifice of the urethra, make it impossible to command considerable portions of the cavity of the bladder with the lithotrite, or indeed with any instrument introduced into the urethra or through a perineal incision, besides favoring the escape and retention of fragments of calculi during litholapaxy.

Chismore used local anæsthesia, and conducted his crushings in a series of short office sittings. He emptied the bladder, injected one or two fluidounces of a four per cent. solution of cocaine hydrochlorate, gently inserted the lithotrite and seized and crushed the stone. He continued to crush so long as fragments were readily found, washed out the pieces, and stopped the moment spasm of the bladder, unusual distress, or symptoms of exhaustion occurred. According to his method, if pieces are left after the first crushing, these are removed after the reaction due to the operation has subsided, and their presence can be recognized with stone-searcher or cystoscope, usually within a week. The partial operation with evacuation of the fragments is then repeated until the bladder is clear.

The male blade of Chismore's lithotrite is hollow, and is attached to an evacuator of simple and ingenious construction. As the stone is crushed it is evacuated through the male blade. This avoids repeated passing of instruments, and is also a valuable means of drawing into the grip of the lithotrite calculi which otherwise could not be reached; for when the instrument is opened, if the bulb of the evacuator is compressed and then suddenly released, fine fragments will be drawn through the cannula of the male blade and into the receptacle placed externally, while fragments too large to pass will be sucked exactly into the grip of the instrument. This operation may be conducted in the office. Following operation there is usually an immediate sense of relief; the reaction is slight. The patient's sensations prove a valuable guide as to the presence or absence of further fragments.

There has long been a popular belief that in children lithotomy is a safer operation than litholapaxy. Statistics have established beyond cavil the greater safety of the latter operation.

Cabot and Barling record for perineal lithotomy, 602 cases, 19 deaths,—a percentage of 3.1; suprapubic lithotomy, 637 cases, 84 deaths—a mortality of 13.1 per cent.; litholapaxy, 284 cases, 5 deaths,—a mortality of 1.7 per cent.

No age is exempt from calculus, since it has been found in the fœtal bladder. About half of all cases of vesical stone are observed in children: hence in them operation for its removal is frequently required. Keegan states that the urethra of a child from three to six years of age will usually accommodate a No. 6 to No. 8 English lithotrite, while a No. 12 to No. 14 can be passed into the urethra of a child of eight to ten years.

Otis has shown that in children as in adults the small diameter of the urethra may be greatly increased with entire safety. He states that the proportionate relation between the circumference of the urethra and that of the penis which he believes to exist in adults holds good in children. Thus, with a penile circumference of one and a half inches, as in a child from two to

three years of age, the size of the urethra would not be less than fifteen millimetres. For every quarter of an inch added to the penile circumference two millimetres may be added to the urethral calibre. It should be remembered that this indicates rather the distensibility than the actual calibre of the canal.

Recurrence of stone may be observed after any operation. Keegan after an extended experience is convinced that this recurrence in male children does not follow litholapaxy oftener than it follows lithotomy.

The urethra and bladder of children are tolerant of instrumentation: hence litholapaxy is advised for small stones or those of moderate size (from three-fifths to four-fifths of an inch in diameter), and for larger stones lithotomy. It is fairly easy to determine the approximate size of calculi in children by

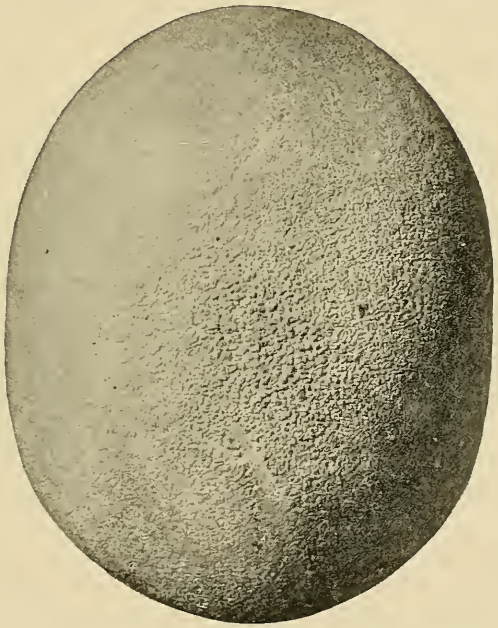


FIG. 263.—Uric acid calculus. Exact size. Weight, nine and one-half ounces. Removed by suprapubic section.

bimanual palpation. Guided by this, or by the cystoscopic appearance, the appropriate method is selected.

In children litholapaxy is the operation of choice when the surgeon is provided with at least two lithotrites of proper size, with evacuating tubes and smoothly working aspirator, and has had previous experience in the use of similar instruments on the adult. Since few surgeons have either the tools or the skill to use them, and fewer still this desirable combination, the cutting operation remains the one of choice in the majority of cases.

In children it is especially important that the instrument should be withdrawn and reintroduced as seldom as possible. A lithotrite which fits the urethra tightly should not be used, since the entrance of the calculus sand into the urethra may render the withdrawal of the full-sized instrument exceedingly diffi-

cult. This also interferes with the introduction of evacuating tubes of adequate size. In seeking for or attempting to seize the stone, care should be taken to avoid such wide separation of the blades as will bring the male blade in frequent contact with the vesical neck. The crushing should invariably be done only after wide separation of the blades as will bring the male blade in frequent contact with the vesical neck. The crushing should invariably be done only after rotating the blades into the centre of the bladder. Every particle of the calculus should be evacuated. Copious irrigation of the anterior urethra through a soft catheter carried to the compressor urethræ muscle aids in freeing it from fine solid particles which may be lodged on its surface.

After crushing and evacuation the bladder is thoroughly irrigated and subjected to cystoscopic examination for remaining fragments. Thereafter an

FIG. 264.—Uric acid calculus. Exact size. Weight, nine and one-half ounces. Removed by suprapubic section.

indwelling catheter is employed or not in accordance with the severity of the preceding cystitis and the thoroughness with which all fragments have been evacuated.

CONTRA-INDICATIONS TO LITHOLAPAXY are—Inexperience on the part of the surgeon with the handling of the needful instruments; difficulty in their passage; a stone so placed or of such size and hardness that it cannot be seized or crushed (Figs. 263 and 264)—these conditions should cause other treatment than litholapaxy to be selected.

Statistics of operation performed upon calculus patients ranging from puberty to middle age are as follows: perineal lithotomy, 226 cases, 22 deaths, 9.7 per cent.; suprapubic lithotomy, 159 cases, 18 deaths, 11.3 per cent.; litholapaxy, 485 cases, 22 deaths, 4.5 per cent.

The greater safety of litholapaxy in old age, as shown by statistical evidence,

is even more striking than in childhood or middle age. Perineal lithotomy, 69 cases, 13 deaths, 19 per cent.; suprapubic lithotomy, 91 cases, 17 deaths, 18 per cent.; litholapaxy, 581 cases, 40 deaths, 7 per cent. In old age the usual contra-indication to litholapaxy, in addition to those mentioned as applying from puberty to middle age, is enlargement of the prostate so pronounced that the lithotrite either cannot be introduced, or if successfully passed cannot reach the stone, even though an effort be made to lift this from the post-prostatic pouch by a finger in the rectum.

Complications of Litholapaxy.—It may happen that the surgeon, having taken it for granted, because of the history of the patient, that the urethra will receive his instruments, finds some obstruction which prevents them from passing. Usually this is because of a narrow meatus. In that case it is at once obviated by meatotomy. It may be from an anterior stricture. This should be treated by internal urethrotomy, the patient then wearing a continuous catheter for a few days after litholapaxy. If the stricture is deep and dense, this indicates median perineal lithotomy or litholapaxy together with urethrotomy. If the obstruction is in the prostate and cannot be overcome without the use of force, the crushing operation must be abandoned.

It may happen that though the urethra receives the lithotrite, the smallest evacuating-tube which the surgeon has fails to pass. If the stone is crushed before this is discovered, it constitutes an embarrassing complication, since, even after the finest practicable fragmentation, it is unsafe to allow the fragments to be passed through the urethra. It is with the idea of avoiding this complication that we have advised injection of the bladder through the evacuating-tube which the surgeon intends to use. He will then discover before having crushed the stone that the tube cannot be passed, and can either procure a smaller tube or at once proceed to remove the stone by the appropriate cutting operation.

If the stone has been crushed and no evacuator can be introduced, cystotomy should be performed and the fragments removed by the scoop and irrigator.

The lithotrite may jam with the blades so widely open that their withdrawal when in this position would almost certainly entail laceration of the urethra. If a series of quick jarring closures fail to free the blades, they should be turned forward against the anterior surface of the bladder and be cut down upon above the pubis; or they may be reached and cleared by perineal incision. Bending of the blades may require similar operations. Should the blades break, the shaft should be removed, if possible, without the exertion of force; the fragments can then be taken out by a median perineal operation. It is to the credit of the instrument-makers that very few lithotrites have been bent or broken in crushing stones.

The bladder may be ruptured during preliminary injection or during attempts at evacuation of the stone fragments. Rupture during injection would be suggested were it found impossible to move the blades of the lithotrite freely in the bladder for want of room, thus showing it to be partly or completely empty. If this accident occurred during the use of the evacuator, unusually free bleeding would be noted, and the liquid injected would fail to return, the mucous membrane being constantly sucked into the eye of the evacuating-tube, in whatever position this might be placed.

As sequelæ of litholapaxy there may develop—(1) Shock or collapse, resulting fatally in a few hours. (2) Hemorrhage. (3) Suppression of urine, which may be fatal in one or two days. This is observed in old persons with crippled kidneys, in whom the slightest interference is liable so to disturb equilibrium that the kidneys become insufficient. (4) Urinary fever. This may be transitory, passing off in from twenty-four to forty-eight hours, or may develop into a true septicæmia. (5) Ascending pyelonephritis, with the development of surgical kidney. (6) Prostatitis and epididymitis. (7) Pelvic cellulitis extending from a pericystitis. (8) Phlebitis involving primarily the prostatic plexus, sometimes extending to the whole pelvic venous system, and causing extensive thrombosis with œdema of the legs, or septic embolism and death from pyæmia. (9) Peritonitis. This may be caused by extension of inflammation due to trauma inflicted on the bladder wall. With the exception of uræmia of the aged, these complications are rare if proper care is taken, and can be readily avoided.

Lithotomy

Lithotomy means an incision into the bladder for the removal of stone. The bladder may be opened through the perineum by lateral, bilateral, median, or mediobilateral incisions. It may be opened through the abdominal walls by a suprapubic incision.

Perineal Lithotomy.—This operation, because of its low mortality, ease and speed of performance, and adequacy to meet the known indications as ascertained by cystoscopic examination, would be the one of choice in approaching the bladder but for the fact that through the opening thus made neither ready inspection nor comfortable palpation is possible; nor is the damage done to the prostatic urethra and ejaculatory ducts entirely negligible.

In all forms of perineal lithotomy the following anatomical landmarks should be considered. The perineum is triangular in form, having its apex at the symphysis pubis, and for its boundaries the rami of the ischia and pubis laterally, and an imaginary line passing through the centre of the anus and connecting the tuberosities of the ischia. The perineal centre is a point midway betwen the centre of the anus and the perineo-scrotal junction; it marks the middle of the lower edge of the triangular ligament. Just in front of this point are the bulb of the penis and its arteries. The raphe extends in the mid-perineal line from the anterior edge of the anus up over the scrotum. Beneath it there are no arteries of importance.

The depth of tissue between the skin and the bladder in the male adult varies from two and a half to three inches when measured near the base line of the perineum.

Lateral Lithotomy.—The following instruments are needed for the lateral operation: a scalpel with a three-inch blade and a moderately heavy handle; a probe-pointed bistoury, for enlarging the prostatic incision, should this be necessary; a large curved lithotomy staff (Fig. 265), grooved on the under surface; the groove should be deep enough to prevent the knife from slipping out when once engaged; straight and curved lithotomy forceps (Fig. 266), the straight answering for most purposes except when the calculus is lodged in a

pouch posterior to the prostate, when the curved forceps will be required; a scoop (Fig. 267) for dislodging the calculus from a sacculation, for removing débris, etc.; a catheter *en chemise*, or a Buckston-Browne air-tampon, for controlling hemorrhage, should it be excessive.

The catheter *en chemise* is made by passing a gum catheter through the centre of a piece of gauze or muslin four inches square; the muslin is slipped along the catheter till it is about one inch from its eye; it is then firmly

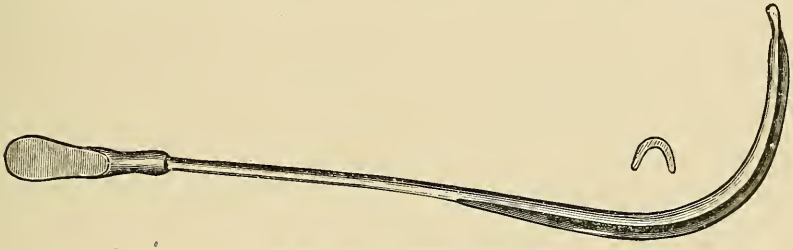


FIG. 265.—Grooved lithotomy staff.

wrapped with silk about the point of puncture, thus securing it in place and allowing the muslin or gauze to hang free as would a petticoat. When needed to stop bleeding, this catheter is passed into the bladder through the wound, and the space intervening between the muslin and the catheter shaft is then packed with iodoform or other antiseptic gauze. Buckston-Browne's air-tam-

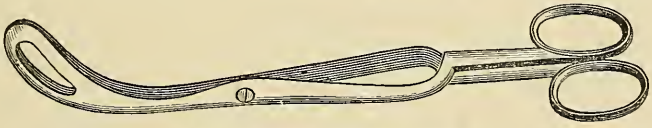


FIG. 266.—Stone forceps (curved).

pon acts as does the Barnes bag, being inflated after it has been put in position: the air-bag surrounds a catheter.

A lithotrite should be provided, in case the stone should be too large to be removed whole, and also the surgical instruments required in all cutting operations,—*i.e.*, knives, scissors, dissecting forceps, hæmostatic forceps, tenacula, grooved director, and probe. Preliminary disinfection of the urethra and the operative region having been accomplished, and the rectum having been

FIG. 267.—Calculus scoop.

emptied, the patient, thoroughly anæsthetized, is placed on the table. Previous to beginning the operation the stone is again sought for; unless it is found at this time, the operation should be postponed. If it is detected, the urine is drawn by a catheter, and from six to eight ounces of boric acid solution or other antiseptic are injected; the patient is then brought to the edge of the table with his thighs well separated and flexed on the abdomen and the legs flexed on the thighs, the position being maintained either by assistants or by mechanical contrivances. The buttocks should project slightly over the end of the table.

The grooved staff is then passed into the urethra. Its tip being well within the bladder, the curve of the staff is pulled up against the symphysis; its shaft should be exactly in the middle line or inclined a little towards the right groin. The surgeon, having placed the staff as he wishes it, directs an assistant to hold it exactly in this position. The incision is made from a point an inch and a quarter in front of the anus and a little to the left of the raphe, downward and outward for three inches, to about the middle of the space between the anus and the tuberosity of the ischium, inclining slightly more towards the ischium to avoid injuring the rectum. The first incision is deeper anteriorly, and divides the skin, superficial fascia, transverse perineal muscle, a few posterior fibres of the accelerator urinæ, branches of the superficial perineal vessels and nerve, and the inferior edge of the superficial layer of the triangular ligament; at the posterior portion of the incision the inferior hemorrhoidal vessels and nerves are laid bare. All freely bleeding vessels are at once secured by hæmostatic forceps, which are not removed till the operation is completed. The space containing the membranous urethra bounded by the superficial and deep layers of the triangular ligament having been thus opened, the surgeon introduces his finger into the wound and feels for the groove of the staff. Finding it, and with his left forefinger as a guide, the point of the knife is passed into the groove, and, by either pushing the staff and knife backward together or following the groove with the point of the knife, the bladder is entered at its neck. To extract the calculus easily it is necessary to incise the left lobe of the prostate: this is accomplished by depressing the knife so that the greatest cutting pressure is brought to bear on the heel of the blade. The blade of the knife should be kept parallel with the external wound. This cut divides the deep layer of the triangular ligament, the anterior fibres of the levator ani, a portion of the compressor urethræ muscle, the left lobe of the prostate, the membranous and the prostatic urethra, and nicks the vesical neck. A deep incision into the neck of the bladder may cause serious hemorrhage from wounding of the prostatic plexus of veins, or, by opening the recto-vesical fascia, may allow of urinary infiltration. If the staff is kept well up against the pubis and the blade of the knife is not permitted to leave its groove, the incision into the prostate and the neck of the bladder is not likely to be too deep. The entrance of the knife into the bladder is marked by a rush of urine or of the fluid injected. The prostatic wound may be enlarged during the withdrawal of the knife, endangering the rectum. The better plan is to make the wound as free as is required, by depressing the handle during the passage of the knife inward, when its tip is engaged in the groove of the staff. Having thus opened the prostatic urethra and the vesical neck, the left forefinger of the operator, guided by the groove of the staff, is introduced into the bladder; when the stone is felt the staff is withdrawn.

The operator's finger being within the bladder, the closed forceps is introduced along this as a guide until the blades are well inside. It is then opened and rotated on its long axis to the right, thus enabling the right-hand blade to act as a scoop, which slides beneath the calculus. When the stone is firmly grasped in the forceps it is removed by traction made upward and forward in the line of the pelvic axis. A slight rocking motion often assists in its delivery.

When the stone is oblong or irregular in shape it is important so to grasp it that its smallest dimensions shall be presented to the opening.

In children the use of a blunt gorget is of use, owing to the prostate being a rudimentary body and the vesical neck not being of sufficient size to allow of the introduction of the finger. The forceps, guarded by the curved surface of the gorget, are introduced, with somewhat more of an inclination towards the symphysis than in the adult, owing to the relatively high position of the bladder in children.

Failure to find the calculus at the first trial may be due to its lodgement behind the prostate. Repeating the attempt and meeting with no success, the curved forceps should be substituted and introduced with the points downward and the handle slightly raised, when the calculus will usually be found. If the calculus cannot be removed, owing to the edges of the wound overlapping, the fingers may be used as retractors or a sufficient incision made with the probe-pointed knife, the incision being preferable to tearing the wound in the effort of extraction. The bladder should be explored with either the finger or a sound after the stone has been extracted, to be certain that no other stone remains. Every portion of its walls should be felt. This is facilitated by making suprapubic pressure while the examining finger is in the bladder.

Soft calculi, by breaking into several pieces from the pressure of the forceps, usually prolong the operation and necessitate the use of a scoop and careful irrigation in order that all the fragments may be removed. In spite of every precaution a small fragment may remain, forming a nidus for new concretions. Recurrence of stone, however, does not prove that operation was incomplete, this frequently taking place when it is absolutely certain that the bladder has been emptied.

Other complications may occur. Among them is excessive hemorrhage following the first incision, and due to wounding of the artery of the bulb, either from its anomalous position or because the incision is carried too far forward; or the distended hemorrhoidal vessels may be the source of the bleeding. Hemorrhage from such a source is easily controlled by means of hæmostatic forceps, replaced by ligatures at the termination of the operation.

Hemorrhage from the deeper incision is rarely profuse, and usually stops from the pressure of the fingers or of the instruments introduced. These proving insufficient, a catheter *en chemise,* or a Buckston-Browne tampon, may be inserted after the removal of the calculus; this usually controls it.

Through careless manipulation the staff may not enter the bladder, but may be caught in a pouch of the urethra. Should such an accident occur, the staff should be withdrawn and reintroduced until it is brought in contact with the stone.

It has happened in lithotomies performed on children that, owing to the small size of the incision in the vesical neck and the prostate, efforts at introducing the finger into the bladder have resulted in tearing the membranous urethra completely across and pushing the bladder up out of the pelvis. Such an accident demands suprapubic cystotomy, the suturing of the torn ends of the urethra, and the passage of a catheter from the bladder out through the urethra.

Wounding the rectum, due to insufficient lateralization of the knife, sometimes occurs; the wound usually heals spontaneously, though a fistula may follow. To guard against such a result, the rectal wound should be stitched as soon as discovered.

Peritonitis has resulted from opening the posterior wall of a contracted bladder: to obviate such an accident, the bladder should be moderately distended with fluid, and the knife should not be carried too far forward into the wound.

The perineum may be so deep that it will be impossible to introduce the finger into the bladder to guide the forceps to the stone. Should such perineal depth be anticipated, suprapubic operation should be chosen. When this condition is discovered after the incision has been made, a blunt gorget, with thin but not sharp edges, may be used to guide the forceps, the gorget being withdrawn as soon as the stone is grasped.

Prostatic enlargement or fibrosis of the internal sphincter may necessitate the use of the gorget as a guide instead of the finger. In these cases there may be such extreme rigidity of the neck of the bladder that full dilatation of the prostatic urethra will be required before instruments for the extraction of the stone can be passed. A pair of straight or curved Spencer-Wells forceps, opened out after introduction into the wound along the groove of the staff, is then serviceable. Forcible dilatation of the prostatic urethra may be followed by complete disappearance of the urinary symptoms.

It may be hard to complete the operation because of the size of the stone. A calculus over two inches in diameter could scarcely be removed through the perineal opening unless the incision were dangerously large or the tissues seriously bruised. Cystoscopic, X-ray, and bimanual palpation should always detect a stone of this size, and should prevent the surgeon from making efforts at removal by perineal operation. In case previous examination has been neglected and the bladder is already open, the stone may be crushed and removed in fragments.

Sacculation may make the removal of the stone through the perineum impossible. This condition calls for the suprapubic cut.

After-Treatment of Perineal Lithotomy Cases.—The bladder, having been cleared of calculi and incrustations, should be well irrigated with hot sterile salt solution or protargol (1 to 4000) (110° F.). This removes small fragments and clots and serves to control hemorrhage.

Should hemorrhage from the bladder-neck or the prostate persist, the air-tampon or the catheter *en chemise* is inserted. This may be removed within forty-eight hours.

When there is cystitis, particularly if this is of long standing, perineal drainage is indicated. This is best secured by a full-sized gum catheter (30 F.) the tip of which lies just within the vesical sphincter. A rubber tube conveys the urine to a vessel at a lower level than the bladder, the free end of the tube being submerged in an antiseptic solution. A light gauze dressing and a T-bandage complete the toilet of the wound, drainage being continued until the urine is clear, usually from three to eight days. The catheter is changed every second day; the bladder is irrigated twice daily, and each time this is done the gauze dressing is changed.

Should there not have been cystitis nor continued oozing, tube drainage is unnecessary; if hemorrhage does not require packing of the wound, a pad of iodoform gauze is loosely applied to the perineum, care being taken that it does not prevent the free escape of the urine from the wound. This escape continues for several days, and then stops for a day or two, owing to inflammatory swelling, then is again noticed, but becomes less marked till it ceases on final closure of the deep wound.

The patient should keep to his bed not longer than three days; suitable absorbent material (pillows of oakum enclosed in one layer of gauze, and frequently changed) should be placed so that it will catch the urine, and his thighs and buttocks protected from irritation by the urine by alcohol baths, followed by applications of thick zinc ointment, boric ointment, or carbolated petrolatum.

Immediate suture of the perineal incision is attended with risk, owing to the fact that the deeper portion of the wound, being more or less bruised by instruments, may slough, and in the absence of drainage cause cellulitis. If the wound is allowed to remain open and heal slowly, granulation proceeds from the bottom surfaceward.

Sitting and walking are indicated as soon as the patient's general condition and perineal soreness permit; the sooner the better.

Median Lithotomy.—In this operation the line of incision follows the raphe between the scrotum and the anus. The patient being in the same position as for lateral lithotomy, a staff grooved on its under surface is introduced and held with its shaft at right angles to the plane of the body, its curve hooked up under the symphysis pubis. The point of the knife—preferably a narrow straight bistoury—is inserted at the perineal centre just posterior to the bulb of the urethra, and pushed on until its point engages the groove of the staff at the membranous urethra, where an incision is made about an inch in length.

The surgeon introduces his left forefinger into the wound and carries it through the prostatic urethra into the bladder, the staff being withdrawn when the tip of the finger engages the vesical orifice, and it is realized that the resistance at this point may be overcome by pressure. In cases of sphincteric sclerosis and contracture a blunt-ended bistoury is passed along the groove of the staff and the sphincter is freely divided, after which the finger will enter without difficulty. Thereafter forceps are passed. The incision divides the skin, the superficial fascia, some fibres of the sphincter ani, the lower edge of the triangular ligament, the compressor urethræ, the membranous urethra, and the apex of the prostate. No vessels of any size are encountered.

The advantages claimed for this operation are that there is no risk of injury to the ejaculatory ducts, and that, no arteries of any size being divided, the hemorrhage is slight. There is some risk, however, of wounding the bulb of the urethra, or the rectum if the cut be carried too far backward.

Dolbeau modified the median operation by introducing a lithotrite through the wound, crushing the stone, and washing out the fragments at one sitting. Owing to the development of litholapaxy, his operation has fallen into disuse.

Bilateral Lithotomy.—This operation, involving the use of a special instru-

ment, Dupuytren's curved double lithotome cache, makes a large opening by cutting from within out both prostatic lobes. The approach to the membranous urethra, through which the closed cutting instrument is introduced, is by a crescentic incision across the perineum.

The sequelæ of lithotomy are much the same as those of lithotrity; there is greater likelihood of troublesome hemorrhages from the prostatic plexus, and of infiltration and cellulitis of the pelvic cellular tissues, because of the incision carried through the prostate. Shock, collapse, urinary fever, thrombosis of the pelvic veins, septicæmia, pyæmia, and peritonitis have all been recorded as following perineal lithotomy.

As remote sequelæ, vesico-rectal or urethro-rectal fistulæ, vesical or urethral fistulæ, and impotence and sterility are possible. Though it would seem difficult

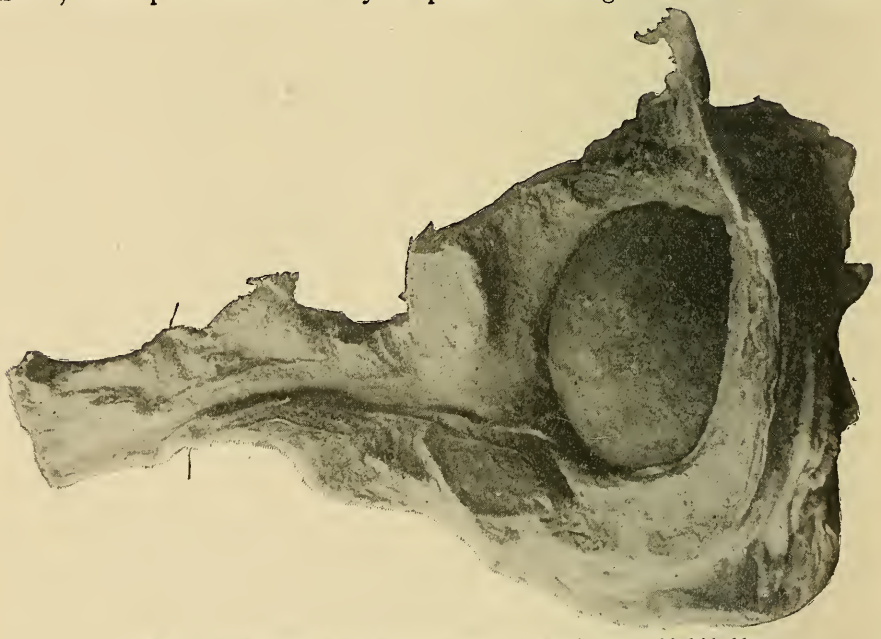


FIG. 268.—Vesical calculus almost completely filling an hypertrophied bladder.

to wound and obliterate both ejaculatory ducts in the operation of lateral lithotomy, there is ample clinical evidence that this sometimes occurs.

Perineal lithotomy would seem to be especially indicated for the removal of small or medium-sized stones (one inch in diameter) from the fairly normal bladder of a fat man with average perineal depth, provided the surgeon is not used to handling crushing instruments. The median or lateral operation should be chosen in accordance for the need for room.

SUPRAPUBIC LITHOTOMY.—Pierre Franco in 1561 is credited as having been the first to extract a calculus through an opening above the pubis. He deemed the operation too dangerous to be repeated, and performed it only as a last resort. The first to perform it in this country—according to Agnew—was Professor Gibson, of the University of Pennsylvania. Unfortunately, the patient died from peritonitis.

At the present day this approach is the usual one for the removal of stones, litholapaxy and perineal lithotomy having been laid aside to be rediscovered and adopted with fresh enthusiasm at a later date.

In preparing for operation the suprapubic and perineal regions, the penis, scrotum, and urethra should be thoroughly cleansed as for any formal surgical procedure. The rectum is emptied by an enema just before the operation.

Local or general anæsthesia may be used. The patient is placed flat upon his back, with the pelvis and shoulders slightly raised to relax the abdominal muscles. The operating-table should be so arranged that the patient can in a moment be placed in the Trendelenburg position, should this be required. The varying relations of the peritoneum to the parietes of the hypogastric region, in accordance with vesical distention, have been already noted. Distention of the bladder rolls back the loosely attached peritoneum and exposes considerable bladder-wall not covered by that membrane. Distending the rectum elevates the posterior portion of the bladder (Fig. 269). The device for increasing the peritoneo-pubic space by distention of both bladder and the rectum is known as the " Garson-Petersen method," and by it this space is increased to its utmost extent.

For the distention of the rectum a dilatable rubber bag,—" Petersen's rectal colpeurynter,"—collapsed and well oiled, is introduced into the rectum above the sphincters. The rectal bag is dilated to the required extent; usually eight ounces of fluid are forced in. A quantity greater than this may injure the rectum. There have been so many reported cases of rectal rupture following the use of the colpeurynter that most surgeons absolutely reject this appliance, holding that moderate injection of the bladder and elevation of the pelvis will give the desired room. The bladder is thoroughly washed through a catheter, and is distended with eight to twelve ounces of a mild antiseptic solution (1 to 4000 protargol) by means of a graduated fountain or large metal syringe. This, without the rectal bag, gives ample room.

In children the amounts injected depend on the age of the patient. Four ounces are enough, since in early life the bladder is an abdominal rather than a pelvic organ.

The bladder having been distended, a three-inch midline incision is made running down to the pubic symphysis, passing between the recti and pyramidales muscles, dividing the sheath of the rectus and the layer of transversalis fascia which bounds the prevesical space anteriorly; the posterior layer of this fascia should prevent the peritoneum from being seen. The prevesical fat is gauze-packed upward and backward, carrying the peritoneum with it, and then well above the pubis is cleanly cut through to the bladder-wall, ligation of one or more veins being often needful; this exposure of the bladder is made as high as practicable, the peritoneum being sutured immediately should it be opened. Tearing or bruising of the prevesical fibro-adipose tissue favors sloughing. This complication is usual and apparently unavoidable, and is probably the reason for the higher mortality of suprapubic as opposed to perineal operation. The bladder-wall, having been clearly exposed, is hooked up by a tenaculum, drawn toward the surface as far as practicable, and an incision is made large enough to admit the index finger. Through each border of the bladder-opening

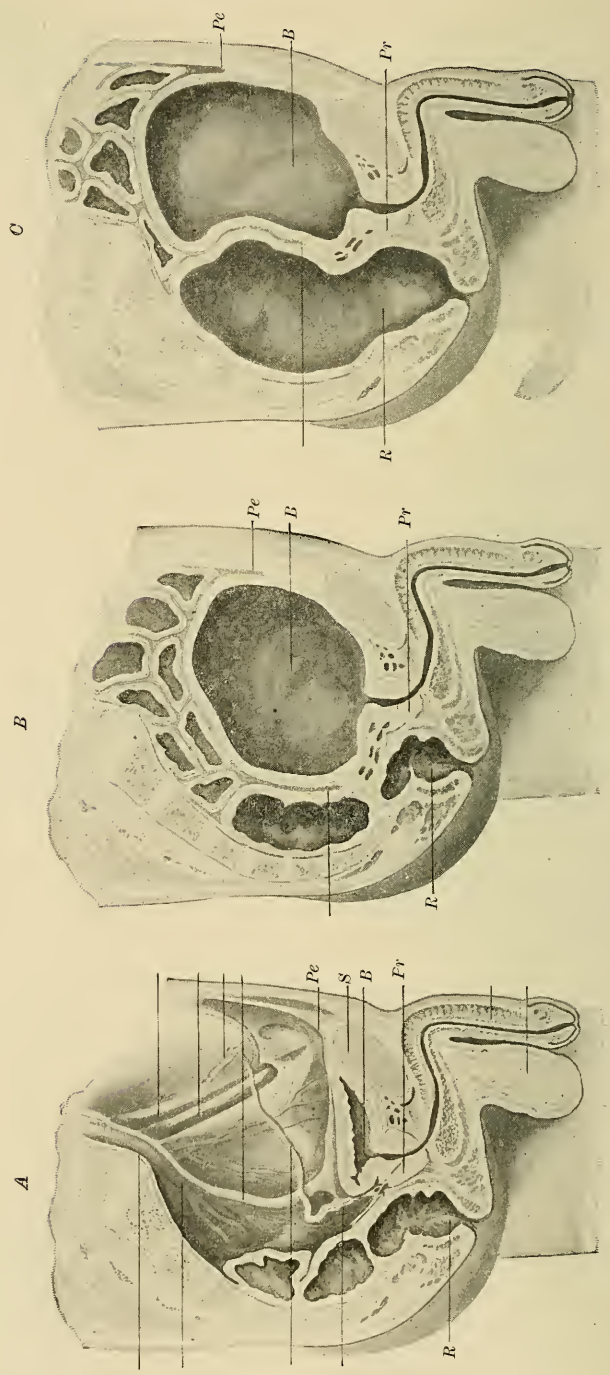


FIG. 269.—Normal relations. Bladder distended. Bladder and rectum distended.

Pe, peritoneum; *B*, bladder; *R*, Rectum; *Pr*, prostate; *S*, symphysis pubis.

a thread is passed, by means of which the wound can be held forward and kept open. Should it be necessary to enlarge the opening, this may be done with scissors. As the bladder empties, the opening in it, if properly placed high, can be drawn completely through the parietal wound, thus protecting the fibro-fatty tissue of the prevesical space from infection and trauma. By placing the patient in the Trendelenburg position and using an electric light the entire bladder, including the vesical opening of the urethra, can be inspected in patients who are not unduly fat. The calculus is removed by the scoop or forceps; if it is encysted, it should be shelled out with extreme gentleness, the opening into the bladder from the diverticulum being nicked and stretched

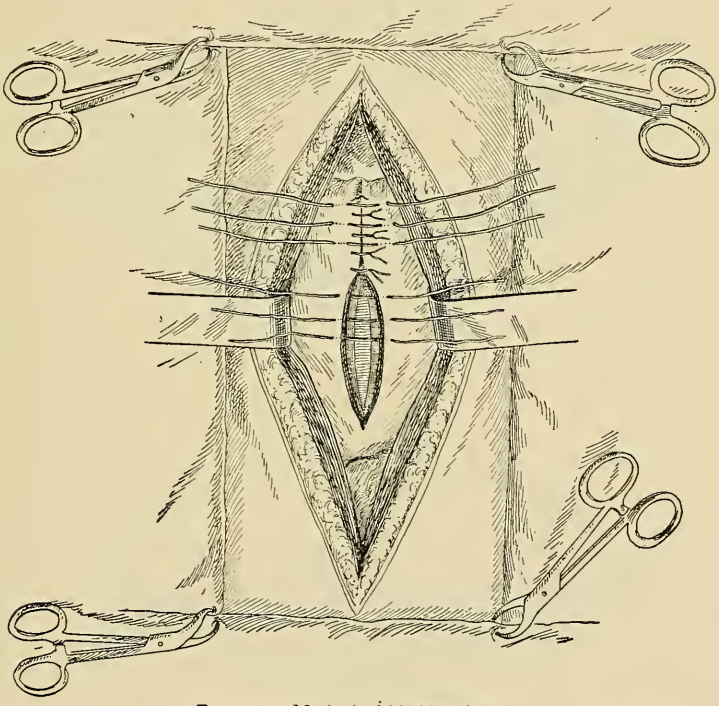


FIG. 270.—Method of bladder closure.

should this be necessary. After removing the major calculus, search should be made for any remaining calculi or fragments. Some stones are so large that the parietal incision may be too small for their delivery (Fig. 268); a transverse cut through the sheaths of the recti may be needful before these muscles can be sufficiently retracted to give the required room.

The condition of the prostate should be noted; the internal vesical sphincter should be stretched by the insertion of the index-finger to the first joint, or cut and stretched in case of fibrosis, or the prostate should be removed if this be indicated.

After-Treatment of Suprapubic Lithotomy Cases.—The after-treatment of the bladder, the stone having been removed, depends upon the condition

of its walls. Provided these are in a fairly healthy condition, immediate suture of the bladder-wound is indicated.

When the bladder wound is to be closed, a double tier of sutures should be inserted. The first of these is an over-and-over stitch of the musculature of the walls. The mucous membrane is not included in the suture. dependence being placed upon the muscular approximation to bring the margins of the mucosa together. The second tier is also placed in the muscular coat, and is of the Lembert type, either interrupted or continuous (Fig. 270). To determine whether or not the lines of suture are tight enough, the bladder is moder-

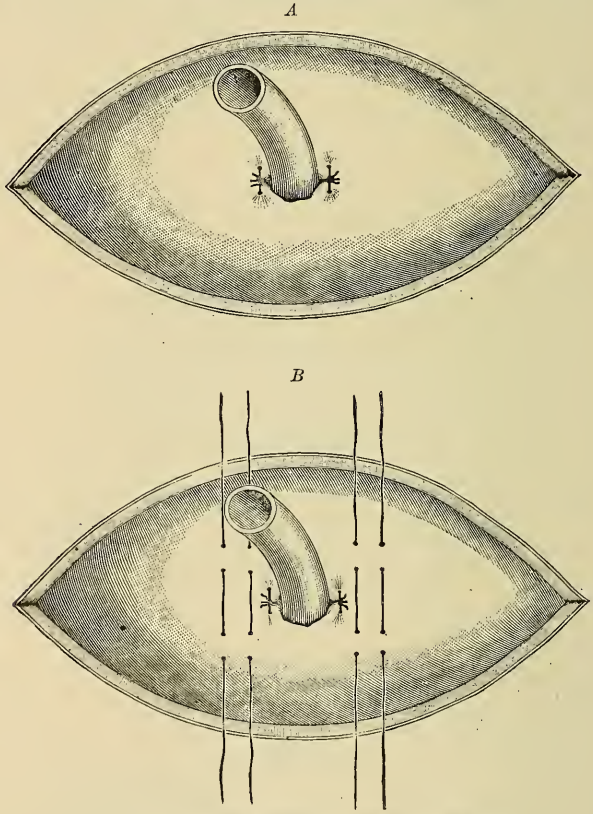


FIG. 271.—Gibson's method of closing the bladder.

ately distended with a mild antiseptic solution, while the line of suture is watched for leakage. The prevesical space should always be drained for forty-eight hours, preferably with a small rubber-covered wick.

After bladder suture continuous catheterization is indicated for from three to five days, supplemented by irrigation twice daily, this including also the urethra, accomplished by drawing out the catheter till the injected fluid appears at the meatus.

In the majority of cases it is a better plan to drain the bladder, and this is essential should there be marked cystitis or should the bladder-walls be in an unhealthy condition. The drainage may be kept up for a few days or for

several weeks, according to the conditions for which it is instituted. For satisfactory drainage a rather large tube (30 to 40 F.) should be used. It should have two fenestræ near its end, and should extend into the bladder for one inch. The bladder wound should be closed above and below the tube by one or two layers of sutures, inserted as previously described (Figs. 271 and 272). The tube from the bladder should lead to a receptacle placed at a lower level, which should contain sufficient antiseptic fluid (phenol or formaldehyde) to cover the end of the tube. Dawbarn's method of suction drainage is illustrated in Fig. 273. Its use necessitates the patient's remaining continuously on

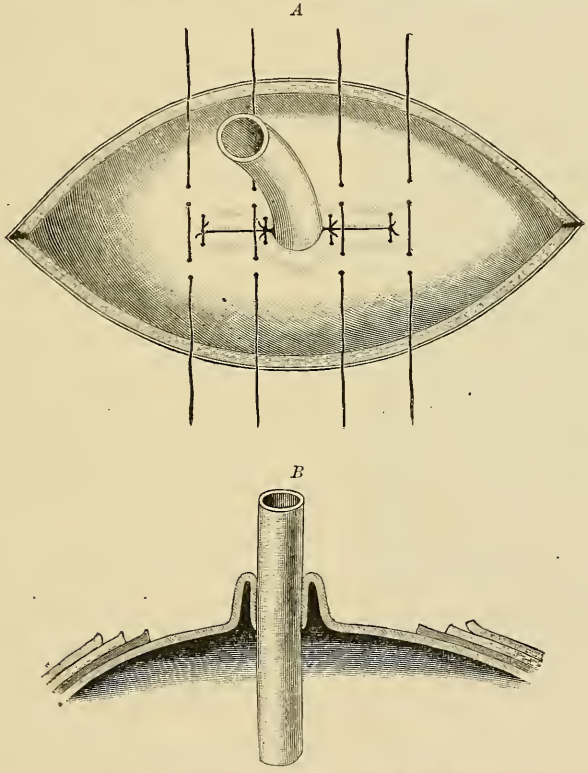


FIG. 272.—Gibson's method of closing the bladder.

his back, and as the apparatus is prone to become disarranged, with consequent wetting of the patient, and requires constant attention to keep the reservoir supplied, its field of usefulness is not a large one.

The drainage-tube having been placed and the vesical wound having been closed about it by catgut sutures sufficiently close to make a water-tight junction, as tested by distention, the prevesical space is carefully dried and drained with a rubber-covered gauze wick. The upper part of the abdominal incision is closed by a buried catgut suture through the fascia and muscles and an interrupted suture in the skin. The bladder should be irrigated twice daily, either through the tube or through the urethra, by means of a short,

conical metal nozzle. When the tube is removed, or should it drain imperfectly, the skin of the lower abdomen is covered with a thick paste of boric or zinc ointment. A large sterile absorbing dressing of gauze and cotton is applied to the hypogastric region, and an oakum pad is placed beneath the patient's buttocks.

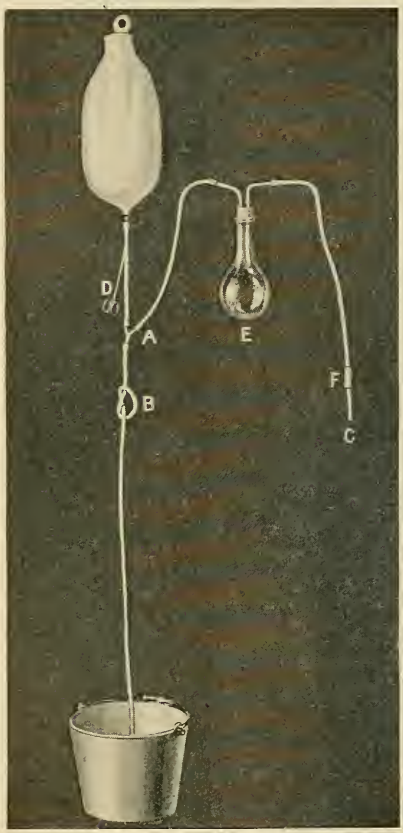


FIG. 273.—Dawbarn's method of suprapubic bladder drainage. Water from the reservoir (a bucket with siphon is better than the bag illustrated) flows down drop by drop till it fills the trap B, consisting of a loosely tied knot in a piece of 26 F. rubber tubing. The trap then empties itself, making suction on the side tube AFC. The small tube C, not larger than 16 F., is inserted into the patient's bladder inside a larger rubber tube, so that there is an air space between the two. The urine is collected in the bottle E. All connections must be air-tight.

Complications and Sequelæ of Suprapubic Cystotomy.—During operation there may be troublesome hemorrhage from the large veins in the perivesical tissue; these are readily secured by hæmostatic forceps. The bladder-wall may bleed freely and persistently, requiring the application of several ligatures.

The peritoneum may be opened; this usually occurs before the bladder has been punctured and while the wound is still sterile. The opening should be closed at once by a fine catgut suture.

Shortly following suprapubic cystotomy, the complications common to all operations on the urinary tract may develop—*i.e.*, shock, collapse, suppression of urine, cellulitis, septicæmia, pyæmia, etc.

Prevesical infection is a common, often a fatal, sequel. It develops in from three to five days, sometimes with evident symptoms of inflammation—*i.e.*, local tumor, pain and tenderness, and general sepsis. Usually the onset of this complication is insidious, the condition of the patient suggesting uræmia rather than suppuration; local symptoms are but slightly marked, or are completely absent, and the temperature is normal or subnormal.

When prevesical sloughing and advancing perivesical cellulitis are suspected, the suprapubic wound should be opened freely, and the space in front of the bladder thoroughly explored and drained.

The suprapubic wound may refuse to close, leaving a fistula. This rarely happens unless there is obstruction to the flow of urine through the urethra or the suprapubic wound becomes tuberculous. The treatment is that generally applicable to vesical fistulæ: urethral obstruction is removed, the bladder is subjected to permanent catheterization, and the fistulous opening is cauterized or excised and the vesical opening closed by suture.

Hernia sometimes follows suprapubic cystotomy, the cicatrix of the parietal

incision yielding to intra-abdominal pressure. A transverse cut dividing the attachment of the recti muscles is much more liable to be followed by this complication than is the ordinary vertical incision. It is treated by a truss or by radical operation.

When the bladder is sutured by silk threads, these by escaping into the vesical cavity may form foci for new calculus-formations.

Treatment of Vesical Calculi in Women

If the stone is quite small, the urethra may be dilated to the required extent, first by suitable dilators, then by the little finger. This being done slowly, there will be but little laceration of the mucous membrane, and the incontinence that follows will be of short duration. The stone may be extracted by means of a scoop or forceps. If the stone is too large to be removed intact, it may be crushed and washed out in the usual manner. If too large and too hard to be removed in this way, or if the bladder requires drainage, vaginal or suprapubic lithotomy is indicated, but this is rarely necessary. Incision of the urethra and neck of the bladder should never be employed on account of the risk of permanent incontinence.

Kelly thus performs the vaginal operation: The patient is placed in the knee-chest posture; a catheter in the bladder, or speculum in the urethra allows air distention of the viscus. The posterior vaginal wall is lifted well upward towards the sacrum by means of a Sims's speculum, and the anterior vaginal wall is brought into view. An incision into the bladder is made through the vesicovaginal septum. The slight hemorrhage passes into the bladder, and thus the field of operation is kept clear. A stone in the bladder or lower portion of the ureter may be easily removed by forceps or a scoop.

FOREIGN BODIES IN THE BLADDER

In addition to calculi there has been found in the bladder an almost unlimited variety of foreign bodies, such as fragments of catheter, hair-pins, pipe-stems, lamp-wicks, pencils, spicules of bone, bullets, shot, etc. (Figs. 274, 275, and 276). These may enter the bladder by way of the urethra, may be driven into the viscus by direct violence, or may gain access by a process of ulceration.

FIG. 274.—Le Fur's case of foreign body in bladder, diagnosed and removed by cystoscopy. Silk suture 12 inches long. The knotted end A, B, black in color, projected into the bladder; the other, B, C, was located in a prevesical cavity, and represents the peritoneal suture of an hysterectomy.

Portions of catheter are more frequently found in the bladder than any other foreign body. The breaking of a soft instrument in the urethra or bladder usually occurs when patients catheterize themselves. Either from ignorance or from carelessness, they continue to use a catheter after it has become weak and brittle.

The mechanism by which foreign bodies introduced into the meatus reach

the bladder has been described in considering foreign bodies in the urethra. Often the introduction of these bodies is suggested by a form of sexual perversion. Sometimes they are passed in for the purpose of allaying the intolerable itching and burning which are symptomatic of posterior urethritis and are referred to the urethra just behind the meatus.

Foreign bodies driven in by force may be pieces of bone, bullets, shot, fragments of clothing, sometimes splinters of wood. Foreign bodies which enter the bladder by the process of ulceration are fragments of bone and the contents of the intestinal canal. Dermoid cysts and extra-uterine pregnancies sometimes discharge into the bladder. Morris says, "Among surgical catastrophies and miraculous recoveries is the case of a pair of pressure forceps left in the peritoneal cavity at an ovariotomy, in which ulceration of the vesical wall occurred

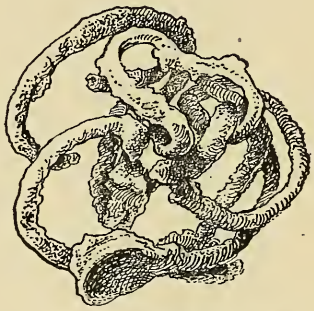


FIG. 275.—Shoestring incrusted with phosphates.

FIG. 276.—Hair pin.

and the forceps entered the bladder and were then successfully removed after a long interval." Morris quotes Guyon and Henriet to the effect that a foreign body once fairly within the cavity of the bladder will usually occupy a transverse position between the summit and the neck and rather nearer the neck. In the empty bladder this is the only position which bodies not longer than four inches can take. A body five inches long assumes either a vertical or an oblique position.

Symptoms.—As in the case of stone, foreign bodies in the bladder may remain quiescent for a long period. Commonly they produce frequent urination, tenesmus and pain, hæmaturia, and, sooner or later, cystitis. If from their shape they exert constant pressure in one portion of the bladder, ulceration and perforation take place, with either the formation of a limited abscess opening externally or into one of the neighboring viscera, or diffuse cellulitis.

Unless the body is expelled shortly after it is introduced, or is of such a nature as to be slowly disintegrated, there is no tendency toward spontaneous evacuation through the urethra. It soon becomes incrusted with urinary salts and grows progressively larger.

Diagnosis.—There is nothing in the symptomatology of a foreign body

to distinguish it from stone. Frequently careful questioning will elicit a history of a catheter having been broken in the bladder, or of a body which has been introduced into the urethra having disappeared, or of a traumatism, such as gunshot wound in the vesical region. In the absence of such history, the diagnosis is sometimes possible after exploration with a vesical sound and bimanual palpation. Thus could be felt a portion of umbrella rib or slate-pencil, for instance. The most reliable means of diagnosis is cystoscopic examination. This will determine the shape, nature, and position of the foreign body, and will enable the surgeon to select the safest and most efficient methods of removing it from the bladder.

When first inserted, foreign bodies are comparatively easy to extract, since there is then no cystitis and little incrustation has taken place. These cases, however, rarely present themselves for treatment until cystitis has reached such a stage as to cause almost unbearable suffering. The body is then thickly crusted with urinary salts.

Treatment.—If the history of the case indicates or if cystoscopic examination shows that the bladder contains a portion of a catheter, it is permissible to attempt first to free it of its incrustation by the gentle use of Young's cystoscopic rongeur, and afterwards to grasp it in the jaws of this instrument and remove it.

FIG. 277.—Hook for the extraction of hair-pins from the female bladder.

Foreign bodies, such as seeds, shot, and pieces of twigs or leaves, may be removed by the tube and evacuator employed in litholapaxy. If the body is of such shape or size that it cannot be taken out through the urethra, cystotomy is indicated. Before the advent of cystitis, either the suprapubic or the perineal route may be chosen. If the foreign body is of large size or irregular in shape, or both, the former route is to be preferred.

When the bladder is infected, or if the foreign body is of such size that it may be readily removed through a comparatively small opening, the perineal incision is the safest. The after-treatment is that applicable to perineal urethrotomy.

In women the greater distensibility of the urethra makes the extraction of foreign bodies much easier. Probably hair-pins are more frequently found than any other foreign body. A special instrument is used by French surgeons for their extraction (see Fig. 277).

CHAPTER XXIV

SURGERY OF THE BLADDER (Continued)

TUMORS

Tumors of the bladder may be benign or malignant.

Benign tumors are the papillomas, the adenomas, the fibromas, the myomas, the myxomas, the angiomas, and cysts.

The malignant growths include carcinomas, sarcomas, and mixed tumors. Carcinomas may be squamous or glandular. The sarcomas may be round-celled, spindle-celled, melanotic, or mixed, as fibrosarcoma, lymphosarcoma, and myxosarcoma. (Fig. 278.)

Of all bladder-growths, more than half are malignant, carcinoma being found more frequently than all other bladder-tumors combined.

Of structurally benign growths, papilloma is commonest. Next in order comes the myxoma, or bladder polyp; adenoma, myoma, angioma, and fibroma are rare.

The seat of bladder-tumors is usually about the base, in the region of the trigonum. Exceptionally, when single, these growths are found involving the upper two-thirds of the bladder-walls. The mode of attachment of the tumor to the bladder-wall varies in different cases. Sometimes it is attached by a long slender pedicle; or the pedicle may be broad, and there may be infiltration of the surrounding bladder-tissues; or there may be no pedicle; or the entire thickness of the bladder may be involved, the infiltration extending beyond the area apparently diseased. Men are more frequently affected with bladder-tumor than are women. The tumors may develop at any age, but are commonest between the fortieth and the sixtieth year.

The great frequency of bladder-tumors in anilin workers has been pointed out by Rehn, twenty-one cases having come under his observation. Of these, three were benign and eighteen malignant. The patients had been employed in a factory from five to twenty-nine years.

Albarran states that vesical tumors are multiple in twenty-five per cent. of cases. Small, single, well-pedicled tumors are likely to be macroscopically benign; large, infiltrating, sessile tumors are commonly malignant.

Papilloma.—Papillary tumors are multiple in about forty per cent. of all cases. (Fig. 279.) They may be pedunculated or sessile and vary from the size of a pea to that of an orange. They may form a villous surface, made up of closely grouped fine papillæ springing from the mucous membrane, or may appear in the form of a cauliflower growth, each of the papillæ sending out offshoots; in the latter case they usually rise from a comparatively small stalk. It must be borne in mind that all tumors of the bladder may be covered by a villous surface. In the true papillomata, however, the tumor is composed entirely of papillæ. (Fig. 280.) Each papilla is made up of a central capillary loop, together with a stroma of delicate fibrous tissue, covered with layers of

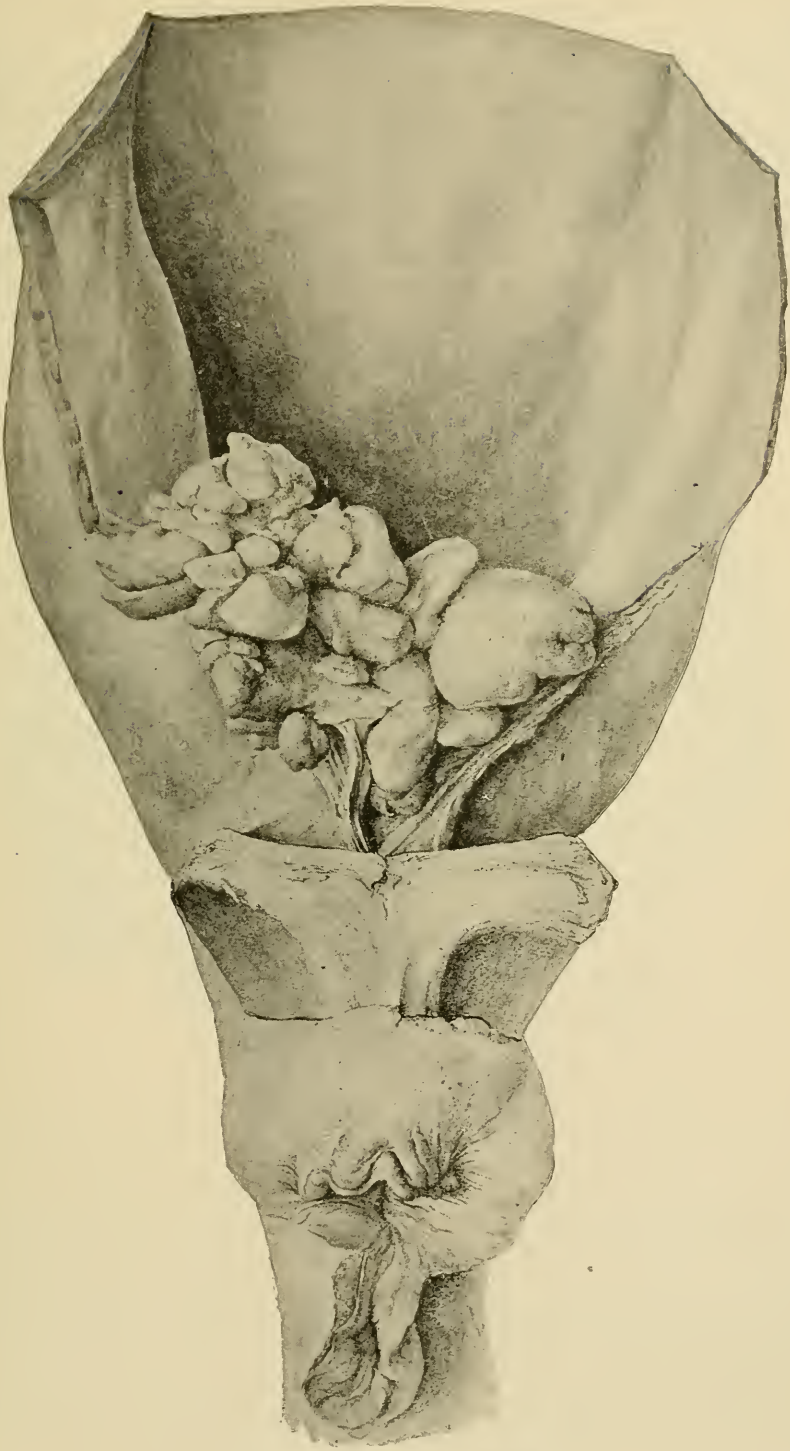


FIG. 278.—Myxosarcoma. (Albarran.)

cylindrical epithelium corresponding in type with the normal vesical epithelial cells. These papillæ are planted upon a fibro-muscular base; the whole mass may be sessile, covering a comparatively large area, or may be pedunculated, the stem sometimes being half an inch in diameter. In some cases papillomata form compact masses with villi of only moderate length.

Transitional forms are found in which the histological structure of the cells (changes in the shape, staining properties, and nuclei of the epithelial elements) shows that these tumors may be transformed into epitheliomata.

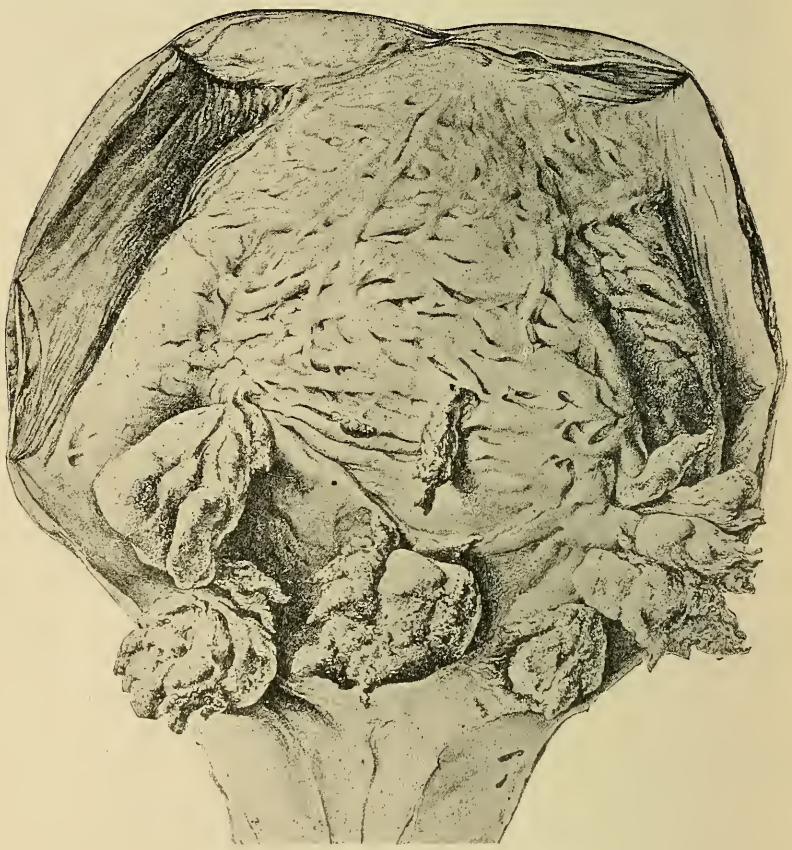


FIG. 279.—Multiple papillomata. (Albarran.)

A necrotic condition of the villi, an œdematous condition of the surrounding mucosa, or nodules in this membrane, failure of the slough caused by high-frequency treatment to separate promptly, and the deposition of lime salts on the tumor following such treatment, together with the presence of palpable induration when the posterior wall is affected, are significant of malignant change (Geraghty).

Villous tumors are prone to bleed from partial strangulation of their blood-supply incident to muscular contraction, and from the fact that the delicate,

loosely floating papillæ are likely to become detached. These may be encrusted with urinary salts.

While the papillomas are here considered as benign tumors, they are so only from the standpoint of the pathologist; to the clinician they are potentially or actively malignant, for not only are they prone to develop malignant changes, but after removal there is a tendency to recurrence, both locally and in other parts of the bladder, probably as a result of direct transplantation. Zuckerkandl reports a case with autopsy in which the bladder and ureter were literally filled with papillomata which had arisen from a mother-growth in the kidney.

Myxoma.—This tumor is much rarer than papilloma. It is most frequently

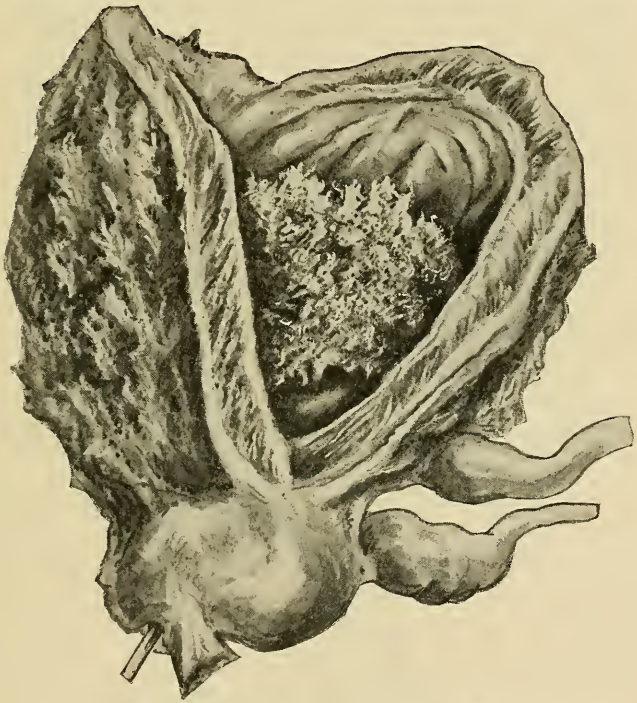


FIG. 280.—Papilloma of the bladder. (No. 4221. From the Mutter Museum, College of Physicians of Philadelphia.)

encountered in childhood, and is probably in some cases congenital. The myxomata are often multiple and pedunculated, and are much like similar tumors found in the nose. Their stroma is made up of fibrous and mucous tissue well vascularized. They are hard or soft in accordance with the preponderance of the mucous or of the fibrous tissue.

When multiple, several tumors may grow from a single pedicle; this, by elongating, may allow the tumors to slip through the female urethra and appear at the meatus. The mucous membrane about the attachment of the pedicle is not infiltrated. These tumors may recur even after a seemingly thorough removal.

Fibroma.—Tumors of this variety in the bladder are excessively rare. They

resemble in structure fibromata formed elsewhere in the body, and are generally sessile; they grow from the mesoblastic structures of the bladder, and are covered with unaltered mucous membrane or villi. They invariably occur in adults.

Myoma.—Myomata of the bladder were supposed by Virchow to be merely

FIG. 281.—Carcinoma of the bladder. (From the Museum of Pathology, University of Pennsylvania.)

prostatic outgrowths, but Belfield has demonstrated that there may be myomata of the bladder pure and simple. They are seldom pedunculated, but are protruded from the muscular coat, often appearing on the outside of the organ as well as in the interior. They sometimes attain a large growth, sufficient to be mistaken for a uterine fibroma, and are extremely vascular.

Angioma.—This is an infrequent vesical tumor, but it is not so rare as some of the solid tumors that have just been described. The venous variety, hæmangioma, as viewed cystoscopically, appears as a characteristic bluish mass.

They occur in or about the ureteral orifice, as a rule, but may be present elsewhere in the mucosa. They may undergo sarcomatous degeneration and may be confounded with melanotic sarcoma.

Varicose Veins of the Bladder.—Aside from the enormous distention of the venous plexus around the bladder, which accompanies prolonged vesical tenesmus and enlarged prostate, there have been observed a few cases of true varicose veins of this viscus. The only symptom is profuse spontaneous bleeding. The diagnosis must be made by cystoscopic examination. When this is positive, and the hemorrhage repeated or threatening, the veins should be ligated, suprapubic cystotomy being done.

Sarcoma.—Tuffier quotes Fenwick, who has collected fifty cases of vesical sarcoma, as saying that in children these growths are often multiple, sessile or subsessile, generally polypoid in form; in the adult they are more often single than multiple, and are pedunculated in only ten per cent. of cases. In thirty-four and a half per cent. of cases they are of the round-celled variety, and in almost seventeen per cent. spindle-celled. They attain a considerable size, sometimes that of a fœtal head. They are generally composed of purely sarcomatous elements, yet villous papilloma degenerating into sarcoma has been observed. Sarcomata are usually multiple. They commonly grow from the neighborhood of the ureteral orifices, or from the mucous membrane lying between these openings. In women infiltration frequently extends along the urethra. From its rapid growth, sarcoma is likely to pass beyond the limits of the bladder, invading the pericystic tissues and finally the bones of the pelvis.

Sarcomatous degeneration may be mixed, giving rise to such forms as angio-, enchondro-, and lympho-sarcoma.

Carcinoma.—This may appear in the form of squamous or tubular epithelioma or alveolar cancer.

Vesical cancer is usually sessile, involves the whole thickness of the bladder-wall, and presents an uneven, often ulcerating, surface (Fig. 281); it is hard on palpation, is surrounded by peripheral induration, and is frequently multiple. The growth is extremely slow. Extensive ulceration is rare. Metastasis may occur very early, before there is extensive involvement of the bladder-wall, or not till the growth has attained large proportions. The affection occurs most frequently in men, and between the fiftieth and the sixtieth years.

At times the growth is pedunculated, suggesting the appearance of papilloma.

On intravesical examination these growths are found to vary greatly in appearance. They may form irregularly projecting masses covered with normal mucous membrane, or they may appear as comparatively flat areas of induration, the surface of which may be smooth or ulcerated. In some cases there is bulk sufficient almost entirely to fill the bladder; very frequently the surface is covered by a papillary growth. Infiltration and induration are the most characteristic features.

When by rectal examination a hardening of the bladder-wall can be felt, this is almost pathognomonic of cancer.

Although extension of the disease to the iliac and abdominal glands and thence to the abdominal viscera occurs, extension to neighboring organs appears to be rare. Watson quotes Barling to the effect that in only three out of

fifteen cases of carcinoma of the bladder did such extension occur; and in nine, in the same series of cases, secondary deposits were found in other organs. Of forty-nine cases, thirty-three had, as secondary changes, hydronephrosis or pyonephrosis, or both.

Cystic Tumors of the Bladder.—The most systematic and detailed study of these rare growths is found in Clado's treatise on Tumors of the Bladder. His teaching in regard to them may be outlined as follows:

Cysts are of epithelial origin, or arise from fœtal inclusion (dermoid cysts).

Epithelial cysts are equally common in men and in women, are observed during any period of life except in early infancy, and are most frequent between the thirtieth and fiftieth years. They are usually placed about the base of the bladder in the region of the vesical neck, probably because the vesical glands are particularly abundant in these regions. They may occupy the entire vesical cavity, and sometimes are associated with cysts of the kidney pelvis. Clinically, they are distinguished according to size, as small or large.

Small cysts appear as minute or medium-sized vesicles filled with clear fluid. This may become turbid or even blood-stained. They may be due either to alteration of the normal vesical glands producing cysts of retention, or to local epithelial proliferation, followed by central softening.

Large epithelial cysts show a tendency to become enucleated from the vesical wall and form pedunculated growths. Vincent records a case in a child between three and three and a half years old in whom the pedicle was so long that the cyst passed through the urethra and presented in the vulva.

Dermoid cysts may invade the bladder primarily or may be paravesical, communicating with the bladder by an orifice. Over forty cases have been reported. These cysts are nearly always observed in women, and symptoms develop between adolescence and old age. The tumor is usually placed at the base of the bladder. Sometimes it appears in the form of a polyp; that is, it is pedunculated. These cysts always contain hair, and the passage of this in the urine constitutes a major symptom. Fragments of bone and teeth are also passed at times.

Microscopically, these cysts show the structure of skin, containing sebaceous glands and hair-follicles in a state of physiological activity. Even small tumors may discharge comparatively large quantities of hair for a long time.

Thirty-two cases of paravesical dermoid cysts have been collected by Clado; seven originated in the ovary, seven formed paravesical tumors; in eighteen the only symptom recorded was micturition of hair.

The dermoid cyst usually remains latent until about the twenty-first year, symptoms of the tumor becoming manifest between this and the fortieth year. The tumor is usually placed in the rectovesical septum, beneath the peritoneum. In two cases it was placed on the apex of the bladder, between the peritoneum and the vesical wall. Sometimes these cysts reach huge dimensions, extending above the umbilicus, and weighing over fourteen pounds. In one case, owing to pressure, retention developed. Calculi frequently form, having for their nuclei masses of hair. These cysts are usually complicated by cystitis of varying degrees of intensity.

Symptoms of Tumor of the Bladder.—The benign bladder-tumor may exist for years and excite no symptoms.

Usually hemorrhage is the symptom which first suggests the possibility of a bladder-growth. The characteristic features of this hemorrhage are its occurrence without apparent cause; its sudden onset, and its abrupt cessation. If the bleeding is copious, if the last urine passed contains more blood than that first evacuated, if the blood is bright red in color, if clots are passed, and if gentle instrumentation occasions free hemorrhage, all the characteristic features of bleeding from bladder-tumor will be present.

This bleeding may last a day, or may continue for weeks, may be so slight as to excite no constitutional symptoms, or may be severe. Exceptionally, as a result of intravesical bleeding, dense clots so obstruct urination that immediate operation is necessary. Frequent recurrences of the bleeding may exhaust the patient, and may finally occasion death. It must be borne in mind that the amount of bleeding is by no means commensurate with the size of the tumor. At times, in place of hæmaturia, or associated with it, there is what Ultzmann calls fibrinuria—that is, in place of pure blood the albuminous constituents of this fluid are exuded through the distended vessels in the region of the growth. The urine when passed coagulates.

Pain usually is not severe, except when there is accompanying cystitis. It is especially marked when the tumor is placed in the region of the vesical neck, and may be reflected to the hypogastric region, the anus, the testicle, the penis, or down the thighs. It is most marked on the completion of urination and when the bladder is invaded by a malignant growth. Benign tumors often cause no pain.

Frequent urination is not a constant symptom. When noted it is not aggravated by exercise, and is not more marked at night. Pain and frequent urination are constant and distressing symptoms when the bladder has become infected; they are then due to the cystitis rather than to the tumor.

Tumors in close relation to the urethral orifice may cause partial or complete retention by mechanical interference with the outflow of the fluid.

The passage of fragments of the tumor is the only absolutely conclusive sign of bladder-tumor, aside from direct examination. A microscopical examination is necessary to determine the nature of the fragments passed, since coagulated fibrin or blood-clot may readily be mistaken for a new growth when examined macroscopically.

Diagnosis.—This is founded on the sudden, apparently causeless free bleedings recurring with increasing frequency, the passage of tumor-fragments, examination with the cystoscope, combined rectal and suprapubic palpation in the case of malignant growths, and exploratory cystotomy. Non-infiltrating growths cannot be detected by palpation.

The successive appearance of single symptoms strongly points to vesical tumor; the immediate association of several symptoms is the rule in cystitis. In the latter the appearance of pus is never long delayed; in tumors it is often delayed. In tumors that infiltrate the bladder-wall, in contradistinction to pedunculated neoplasms, hemorrhage may be a late symptom, while, on the other hand, the irritation of the muscular wall induces frequent urination at an earlier period than in tumors with pedicles. Hæmaturia, intermittent or profuse and lasting a long time without other symptoms, is always suggestive

of vesical tumor rather than of cystitis. A bladder which contains a tumor is peculiarly susceptible to infection.

Prognosis.—Even in benign tumors the outlook of a case allowed to run its course is unfavorable. Very exceptionally individual polypoid growths are discharged spontaneously. As a rule, the growth is progressive. Freyer mentions a case of papilloma existing eighteen years.

From mechanical action a large tumor of the bladder may cause displacement of neighboring organs, pressure upon the rectum, or partial or complete obliteration of the ureters or the urethra.

The patient ultimately perishes, either from exhaustion incident to hemorrhage or from ascending pyelonephritis. The course of these cases is often extremely slow.

When the tumor is thoroughly removed the prognosis in benign cases is good, though recurrence may take place. Even in malignant growths a thorough removal in the early stages may accomplish radical cure.

TREATMENT OF TUMORS OF THE BLADDER

The diagnosis having been established, there is but one treatment to be seriously considered—complete removal of the growth, provided the nature of the tumor permits of such a procedure. The benign tumors as a class are easily removable, and, as many of them are prone to undergo malignant degeneration, their destruction is important not only on account of the symptoms they produce, but also as a prophylactic measure. The removal of malignant tumors in their earlier stages may also be curative.

The palliative treatment of tumors of the bladder is confined to checking bleeding and relieving pain. This treatment may be required because of reluctance on the part of the patient to consent to operation; more frequently because by the time a positive diagnosis of tumor is made infiltration has already extended wide of the bladder, and a radical operation is no longer possible. The treatment of hæmaturia in general is that applicable to the relief of vesical congestion. The most potent measure for the checking of the bleeding is the hypodermic injection of normal serum, human or horse, in quantities of from 10 to 50 c.c., every two or three or four days, according to the result obtained. Local treatment may be conducted by hot injections of alum four drachms to the pint, hydrastis two ounces to the pint, or acetanilid five per cent. solution, or adrenalin solution 1 to 5000. When clots are present and produce retention, they should be aspirated through a catheter, cystoscope sheath, or Bigelow's evacuating tube. If bleeding persists in spite of injections, or if these produce great pain and seem to increase hemorrhage, permanent catheterization is indicated. If this is unsuccessful because the catheter becomes blocked by clots, cystotomy should be performed, with cauterization of the tumor and the insertion of a large tube. Packing the bladder full of iodoform gauze about a drainage-tube inserted down to the bladder base must sometimes be resorted to.

Pain may be quieted by instillations of eucaine. Usually morphine hypodermically will be required for its relief. Cystitis or retention should be treated in accordance with the directions already given.

Hydrastis, ergotin, and gallic acid given in moderate doses by the mouth can at least do no harm.

Curative Treatment.—For the destruction or removal of vesical tumors the surgeon has four methods at his disposal. These are (*a*) the cystoscopic, wherein the tumors are attacked by means of the high-frequency current, snare, or cautery manipulated through a cystoscope; (*b*) cystotomy, with excision of the tumors; (*c*) resection of the bladder; (*d*) extirpation of the bladder.

The exact method to be followed varies with the character of the tumor. Where possible cystoscopic methods should be used, as they are the simplest, incapacitate the patient least, are least dangerous, and, for the destruction of tumors to which they are applicable, are most efficient. Of the cystoscopic methods, that employing the Oudin monopolar high-frequency current is the

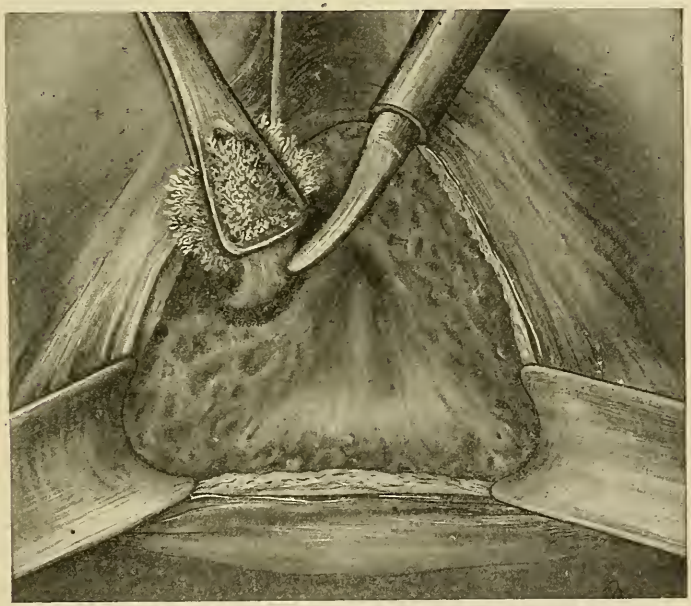


Fig. 282.—Cautery resection of papilloma of the bladder. (Mayo's Clinics, W. B. Saunders Co.)

most used and gives the best results. Papillomata yield readily to it; myxomata with greater difficulty. The denser benign tumors are not suitable for this method of attack, nor are the malignant neoplasms. The details of the method of application will be found on page 56.

Geraghty has found the use of radium, applied by means of a special cystoscope directly to the tumor, in doses of 500 or 600 milligramme-hours, sometimes alone and sometimes in combination with the high-frequency current, to be of value in the treatment of malignant papillomata, which yielded but slowly or not at all to the electric treatment alone.

The immediate results of the treatment of papillomata by high-frequency desiccation have been uniformly good, the growths disappearing after a varying number of treatments. In some of the cases there have been recurrences, but not in as many as when other methods have been used, and in the event of such

recurrences it has not been difficult to obtain the patients' consent to a repetition of the treatment.

The use of the snare and cautery presents considerable difficulty, and requires apparatus of special design, so that they are now but little used.

Cystotomy and Cystectomy

The bladder may be approached above the pubis either extra- or trans-peritoneally. The former is the older method, is the safer as regards infection, but has been discarded by some surgeons on account of the excellent exposure they

FIG. 283.—Removal of large amount of bladder with transplantation of ureter. (Mayo's Clinics, W. B. Saunders Co.)

were able to obtain by the transperitoneal method, which also permits exploration of the liver and lymphatics for metastases. Yet by the procedure advocated by Squier abundant room is provided by the extraperitoneal route, and the exposure is as good as in the transperitoneal operation.

According to the character and location of the tumor, the choice of the operative procedure should be as follows:

When the tumor is apparently benign, but for any reason excision is chosen instead of the high-frequency destruction through a cystoscope, cystotomy may be performed as described for the removal of stone, the bladder incision

being made of sufficient size to provide a good exposure when the patient is placed in the Trendelenburg position and retractors are inserted. The tumor or tumors are removed by grasping close to the bladder-wall with a clamp and dividing the base with the cautery. The operation is concluded by thoroughly flushing the bladder with 1 to 4000 protargol and closing the incision about a drainage-tube, or completely suturing the vesical wound. The prevesical space must always be drained. To avoid transplantation of the tumor to other parts

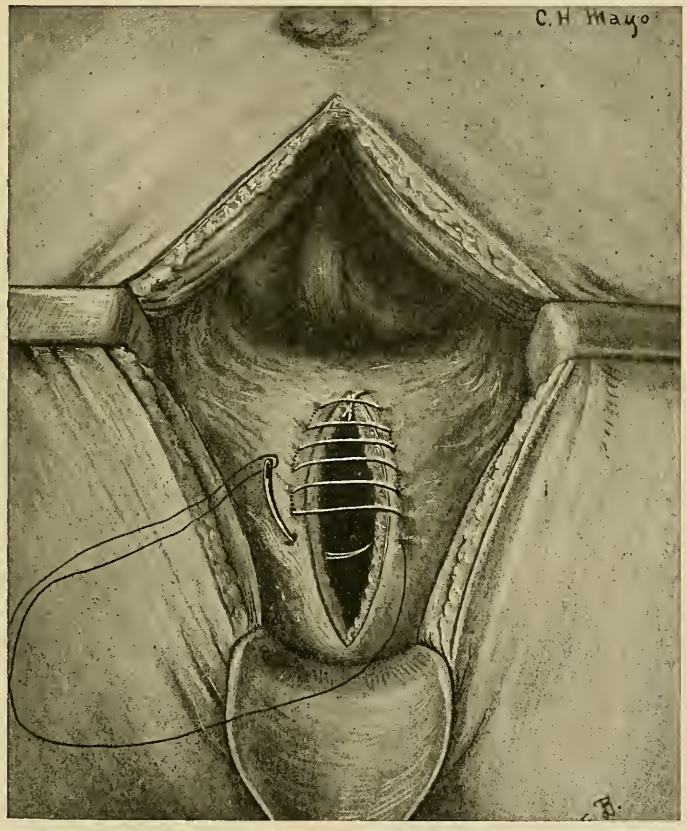


FIG. 284.—Showing method of closure of bladder incision. (Mayo's Clinics, W. B. Saunders Co.)

of the bladder, preliminary cauterization of the neoplasm and the use of alcohol-wet sponges are suggested by Geraghty.

The transperitoneal route should be chosen for the removal of tumors of a probably malignant nature situated on those parts of the bladder-wall which have a peritoneal investment, as it is then easier to remove the whole thickness of the walls, including the peritoneal coat.

The bladder is irrigated and emptied, and the patient placed in the Trendelenburg position. An incision is then made from the umbilicus to the symphysis, the liver and lymphatics searched for metastases, and the intestines gauze-packed into the upper portion of the abdomen. The bladder is then

drawn up into the wound by means of forceps and an incision made about the tumor. When this approach is used for tumors situated near the base of the bladder an incision for inspection is made in the posterior wall; in the case of apparently benign tumors removal is then effected by means of the cautery, as through the suprapubic opening (Fig. 282); if malignancy is probable, an incision is carried down and around the tumor. Should it be necessary to divide a ureter, the proximal portion is brought out through an incision in the peri-

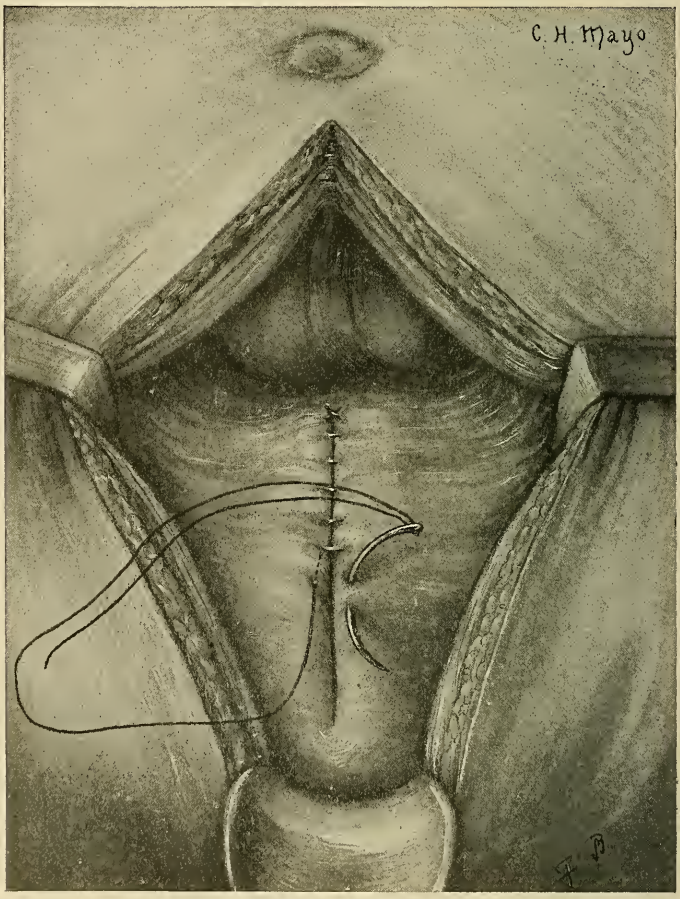


FIG. 285.—Cushing peritoneal suture closing bladder wound. (Mayo's Clinics, W. B. Saunders Co.)

toneum and inserted into the bladder at the most convenient point (Fig. 283). The ureter should be covered over with a fold of peritoneum before completing the operation. The wound in the bladder is closed, as recommended by Judd, by means of a continuous Connell stitch of catgut (Fig. 284), passing through all the coats of the viscus, the knots and loops being placed on the mucous surface, as in suturing the intestine. Should a portion of the bladder incision be through an extraperitoneal portion, Judd recommends that when possible the peritoneum be drawn down so as to be included in the suture. A second

suture line should be placed over the first, the peritoneum alone being included (Fig. 285); the stitches are placed parallel to the line of incision, after the method of Cushing. Drainage of the bladder and of the peritoneal cavity is necessary when there has been transplantation of a ureter and when soiling of the wound has occurred.

The extraperitoneal operation is performed by Squier in the following manner: The abdominal parietes are incised down to the peritoneum from one inch above the umbilicus on the left side to the symphysis, the sheath of the rectus being opened, and that muscle displaced outward. By sponging the fat upward the urachus and obliterated hypogastric arteries are exposed. In some cases Squier opens the peritoneum at this point, in others proceeds extraperitoneally as here described.

By making traction on the urachus the hypogastrics are made prominent, the left one being grasped with forceps and drawn to the right. Then by blunt dissection between this structure and the wall of the pelvis the vas is brought into view, and is followed downward till the ureter is exposed, it being crossed by the vas just before entering the bladder. After exposing the right ureter in a similar manner, the urachus is divided close to the bladder, and the peritoneum is stripped from the posterior surface, the bladder thus being freed except in front, where the attachments to the pubis are left intact.

From this point the operation is similar to the transperitoneal operation described. Squier advocates bladder drainage with a 26 F. catheter through a stab wound in the anterior wall.

Whatever method is followed, it is essential to have some source of artificial illumination. This may conveniently be worn on the forehead, a small battery being hung at the hip, or a small lamp may be placed on the retractor, or the lamp of a cystoscope inserted through the urethra may be used.

Extirpation of the Bladder

Hartley collected twenty-three cases of complete removal of this organ for malignant disease. The total recoveries were twelve, giving a mortality of forty-seven and eighty-three one-hundredths per cent. Five patients died during operation, three of collapse afterward, and four a few days later.

The ureters were implanted into the bowel in eleven cases with six deaths, and into the vagina in seven cases with one death from shock. In this operation, formidable as it seems to be, the chief difficulty is not the removal of the bladder, but the disposition of the ureters. Four procedures are practised:

1. Ligature of the ureter, followed by double nephrostomy.
2. Implantation into the colon.
3. Implanation into the vagina.
4. Ureterostomy in the skin wound. Of these, double nephrostomy gives the most encouraging results.

The operation is indicated only in cases in which complete removal of the malignant disease is impossible by partial resection (*i.e.*, where there is extensive involvement of the bladder base, or where the urethral orifice is included), and in which it is possible to remove all the disease by cystectomy. It is contra-indicated when the malignant disease has extended beyond the bladder, at least when more than the prostate and seminal vesicles are involved.

The patient is placed in the Trendelenburg posture, the bladder is distended, and a vertical incision four or five inches long is made in the median line as in suprapubic cystotomy, but extending higher. This exposes the bladder and the reflection of peritoneum, the latter being pushed well upward. A transverse incision is made from the lower end of the wound, dividing all the parietal structures to each external inguinal ring just above the pubic bone and Poupart's ligament. The rectangular flaps thus outlined are dissected and retracted upward and outward to allow free access to the bladder. While moderate traction is made upward on the lateral aspects of the bladder, the anterior wall is separated by blunt dissection from the pubis down to the vesical neck, which is exposed, isolated, and clamped tightly with two pairs of Spencer Wells forceps. The neck of the bladder is divided between the forceps and each stump cauterized. The peritoneum is carefully peeled and removed from the superior, posterior, and lateral aspects of the bladder by blunt dissection, preferably with the finger, avoiding opening the peritoneal cavity. The inferior vesical arteries and ureters are secured close to the bladder with large curved hæmostats and divided between the forceps *en masse*. The ureteral openings are cauterized at each end and the vesical arteries ligated, after which the base of the bladder may be carefully separated from its attachments and the viscus removed. The stump of the urethra is ligated, all bleeding stopped, and the deep wound packed with gauze, the drainage being brought out just over the symphysis. Both transverse cuts and most of the median incision are sutured, and the external wound dressed.

Harris advises, especially if the prostate is involved, division of the urethra at the triangular ligament while traction is made on the bladder anteriorly, and removing the bladder and prostate together, these being separated from the rectum while an assistant's finger is inserted in the latter.

Complications and Sequelæ

These are similar to those described under suprapubic cystotomy for the removal of stone. Since an operation for the removal of tumor is prolonged and is often attended by profuse hemorrhage, shock and collapse are particularly to be guarded against. Should the patient escape these dangers, suppression of urine, urinary fever, or infection of the kidneys may develop. The most frequent complication is, however, urinary infiltration with cellulitis. Should symptoms point to these conditions, the hypogastric wound should be opened and the space of Retzius thoroughly drained.

Postoperative Treatment.—After a tumor has been treated by means of the high-frequency current no special care is required in the great majority of cases; in occasional instances there is an increment of bleeding, making it advisable for the patient to stay in bed for twenty-four hours.

After removal of tumors by any of the various cutting operations it is well to irrigate the bladder daily, or twice daily, with a mild antiseptic solution (*e.g.*, 1 to 4000 protargol), either through the bladder drain, or by means of a short metal nozzle or a catheter, the method giving the least distress and spasm being used.

After the removal of a vesical tumor the patient should be examined cystoscopically every three to six months for at least three years, that should there be recurrences these may be detected soon after their appearance.

PARAVESICAL TUMORS

These may be solid or cystic.

Myoma is the only solid tumor. Belfield has observed one case, the growth springing from the muscular tunic and projecting as a nodule. Verhoogen found a myoma the size of a child's head attached to the posterior surface of the bladder by a pedicle about as thick as three fingers.

Residual cysts are due to proliferation of the remains of fœtal structures. Englisch has described cysts of the Wolffian and Müller's bodies, of the prostatic utricle, and of the seminal vesicles, also of the urachus.

Inclusion cysts—*i.e.*, dermoids—have been already described.

There is but one example of simple cyst, contributed by Segond. The tumor was found in the muscular wall of the bladder. It was tightly adherent. Clado suggests that it may have originated from an intravesical glandular cyst.

Cysts developing in the prostatic utricle and seminal vesicles are comparatively rare. Utricular cysts are median, provided with a pedicle attached to the base of the prostate, and develop behind the bladder. Those which arise from dilatation of diverticula of the seminal vesicle are always lateral. The median cysts are due to persistence of débris in the duct of Müller.

Urachus Cyst.—Very exceptionally the urachus may remain patent throughout its course or at one end, giving rise to a cyst or fistula. The cyst will form an irregular fluctuating hypogastric tumor simulating sacculated bladder.

Hydatid cysts develop in the pericystic tissue. If the cyst develops in either the anterior or the posterior wall of the space of Retzius, its direction of growth will be limited by the fascia surrounding this space. It will then grow upward towards the umbilicus, but will not reach higher than this point. It may develop in the cellular tissue separating the bladder from the rectum, or it may occupy the true pelvis, in this case growing upward towards the umbilicus.

These cysts may be single or multiple, and are prone to contract adhesions to the bladder and pelvic fascia. The primitive development of the tumors is in the subperitoneal cellular tissue: hence the treatment of these cysts does not necessitate cystotomy.

A fluctuating tumor projecting into the hypogastrium should be extirpated if possible; if this is impracticable, the lining membrane should be removed and the cavity drained. A cyst filling the vesicorectal cul-de-sac should be reached by the crescentic perineal incision described as appropriate for the removal of seminal vesicles. It can be enucleated, extirpated, or drained.

Intravesical ureteral cyst has been occasionally seen as a result of constriction at the entrance of this canal into the bladder, where the stricture occurs at the termination of the ureter on the vesical mucous membrane. In cases of such exceedingly rare conditions there are generally hydronephrosis and congenital abnormal location of the ureteral termination. The condition is really hydro-ureter, with vesical invagination.

CHAPTER XXV

SURGERY OF THE URETERS

ANATOMY

The ureters are slightly flattened, tough, white, fibro-muscular canals, which conduct the urine from the kidneys to the bladder, with the investments of which their three coats are continuous. On an average they are from twenty-seven to thirty-five centimetres in length. Exceptionally they may be longer, though a greater length than forty centimetres has not been recorded. They are about three to four millimetres in diameter, but are not of uniform calibre throughout, being slightly narrowed—(1) at the point of juncture of the pelvis and ureter; (2) at the point of crossing the bifurcation of the iliac artery; (3) at the point of entrance into the bladder. When strictured, or as the result of urethral obstruction, the ureters may become enormously dilated, reaching the size of the small intestine.

The course of the ureters is in general downward and inward. They are separated by an interval of about three inches at their upper portion and less than two inches where they enter the bladder. Their course in their abdominal portion is indicated on the surface by a vertical line passing upward from the junction of the inner and middle thirds of Poupart's ligament. The upper extremity of the ureter corresponds to a point where this line crosses the twelfth rib. The lower extremity of the abdominal portion of the ureter, corresponding to the crossing of the bifurcation of the common iliac artery, is placed slightly below the point where this vertical line intersects a line joining the two anterior superior iliac spines. (Tourneur.)

At its point of origin from the kidney pelvis the ureter lies on a plane behind that of the renal artery. It passes downward and inward, crossing the psoas muscle obliquely to the bifurcation of the common iliac artery. In its course it is slightly convex forward and inward. About the middle of its course, or a little below this point, the abdominal portion of the ureter is crossed by the spermatic artery in the male and by the ovarian vessels in the female. In front lie the cæcum and the ascending colon on the right side, the sigmoid flexure on the left side.

The pelvic portion of the ureter describes a curve with its concavity forward, inward, and upward. It passes beneath the peritoneum, along the walls of the pelvis, and, entering the posterior false ligament of the bladder, crossed by the vas deferens in the male, obliquely pierces the vesical coats just below and to the outer side of the upper extremity of the seminal vesicle.

In the female the pelvic portions of the ureters pass first downward, then forward and inward, in the loose cellular tissue of the pelvis. In the vase of the broad ligament they lie beneath the uterine arteries, which are in close relation to them for a short distance as they pass upward to the uterus; the ureters are continued forward over the anterior vaginal vault into the bladder.

The vesical portion of the ureter, about three-quarters of an inch in length, runs obliquely inward and forward through the muscular layer of the bladder-wall, opening into the cavity of this viscus by a slit-like orifice about three centimetres from its fellow of the opposite side, and an equal distance from the urethral orifice, the three openings marking the angles of the vesical trigonum.

The muscles of the ureter are continuous with those of the bladder. Testut describes a valve-like arrangement due to absence of muscular tissue in the upper wall of the terminal extremity of the ureter. This portion of the wall is made up entirely of a fold of mucous membrane; intravesical tension at once presses this valve-like fold against the low ureteral wall, and thus effectually blocks the tube. Either because of this arrangement or on account of the oblique manner in which the ureter passes through the bladder-wall, the normal orifice does not permit regurgitation of urine.

The relation of the ureter to the peritoneum is important from a surgical standpoint. Cabot has shown that if the surgeon in stripping up the peritoneum has reached the place where it refuses to separate readily from the parietes, he will find the ureter upon the stripped-up peritoneum; on the left side from half an inch to an inch outside this point; on the right side at a somewhat greater distance, owing to the ureter being displaced laterally by the interposition of the vena cava between it and the spine.

The pelvic ureter of the left side lies anterior to and to the outer side of the internal iliac artery close to the rectum; that of the right side passes downward parallel to the internal iliac artery and directly in front. As these canals descend they are covered by peritoneum to the point where this membrane is reflected upward over the posterior wall of the bladder, leaving nearly an inch, which may be incised through the vesical walls without opening the peritoneal cavity.

The mucous membrane of the ureter is continuous with that of the kidney pelvis and of the bladder. Glands are either rudimental or absent. The mucous surface is made up of layers of stratified squamous or transitional epithelium.

The blood-supply is derived from branches of the renal, spermatic or ovarian, and from the ureteric artery springing from the aorta or internal or common iliac (Krause), and in the pelvic portion from branches of the inferior vesical and middle hemorrhoidal arteries. These vessels supply a plexus which abundantly provides for repair in case of injury.

The nerves are derived from the renal, spermatic, and hypogastric plexuses. Pain originating in the upper extremity of the ureter is referred to the kidney; that in the middle portion to the abdomen, and on the right side may be indistinguishable from the pain of appendicitis; while that in the lower extremity is referred to the bladder and ureter. Although, as a rule, the above is true of ureteral referred pain, at times vesical pain is the sole symptom of a lesion of the renal pelvis.

The lymphatics are not distinguishable as networks in the mucosa or submucosa, but are visible as such in the muscular coat and on the exterior. The lymphatic trunks of the lower segment are continuous with those of the bladder,

or are tributary to the internal iliac nodes; those of the middle segment empty into the lumbar nodes; those of the upper segment are either continuous with the renal lymphatics or are tributary to the aortic nodes. Lymph vessels are

FIG. 286.—Colloidal silver radiogram, showing double ureter and double pelvis on left side. (Selby.) (Mayo's Clinics, W. B. Saunders Co.)

also run from the lower ureter to the lymphatics of the kidney and of the perirenal fibrofatty investment, thus providing a means of direct transference of infection to these structures.

From its strong muscular coat, it is evident that the ureter is not merely a channel, but takes an active part in conveying the excretion of the kidney into the bladder. It is well established that the unstriped muscular fibres of the ureter are in a state of intermittent peristalsis. This action goes on independently in the ureters. The contractions are repeated at irregular intervals, and the quantity of urine discharged at each contraction varies greatly, probably averaging from three to ten drops.

Anomalies

The ureter may be absent; in this case the kidney also will be absent. Bruner has collected forty-eight cases of this anomaly. It may be obliterated through a part or the whole of its course. In this event the kidney is atrophic or degenerated. It may be bifurcated at either extremity (Fig. 287, *C* and *D*).

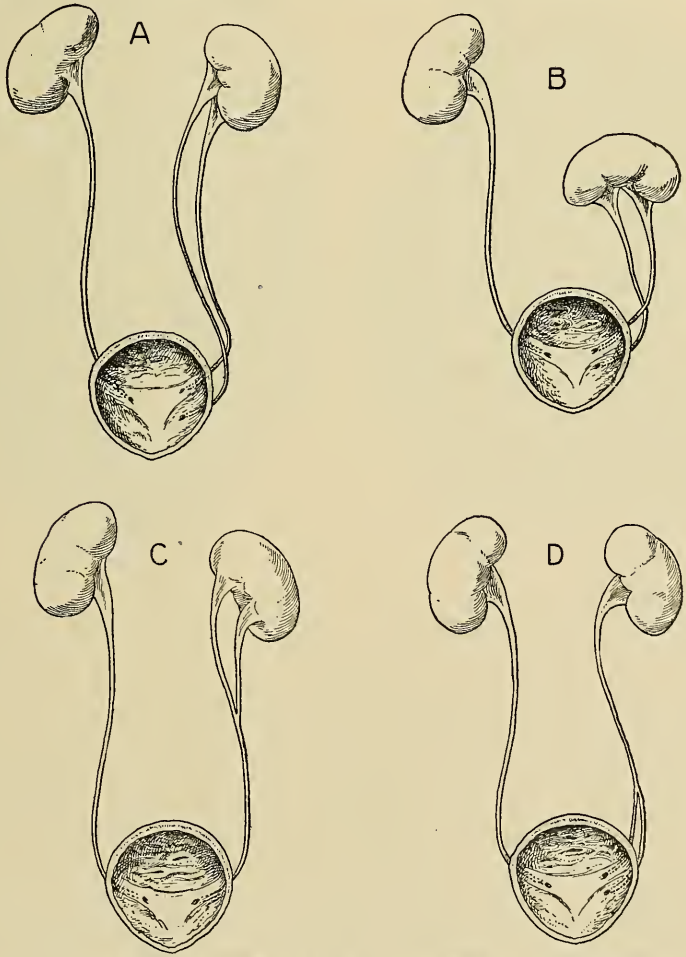


FIG. 287.—Anomalous ureters. A and B, double ureters; C and D, bifurcated ureters.

The ureter may be multiple. Double ureter is usually associated with a kidney which has two pelves (Figs. 286 and Fig. 287, *A* and *B*). Nine cases of bilateral duplication are reported (Levison).

A fused kidney usually possesses two distinct pelves and ureters. Each pelvis, in kidneys with more than two pelves, has its own ureter. In the event of double ureters, the one arising from the inferior pole of the kidney enters the bladder normally at the trigonal angle; the one springing from the upper part of the kidney passes posterior to the other ureter and empties into the bladder, abnormally; that is, below the orifice of its fellow.

The ureter may pursue an aberrant course. This anomaly appears to be chiefly in females. Cases are recorded in which ureters opened into the ex-

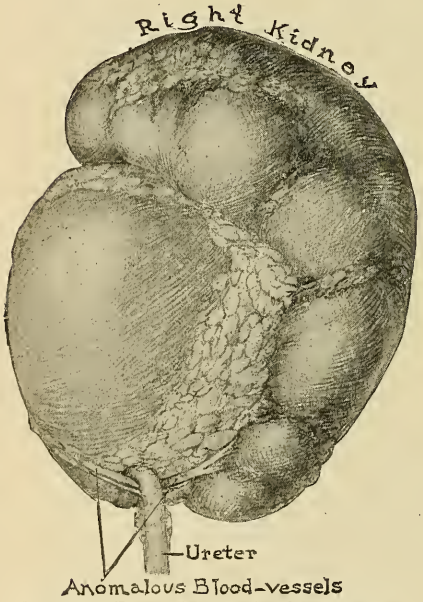


FIG. 288.—Ureter obstructed at its emergence from pelvis by anomalous vessels. (Mayo's Clinics, W. B. Saunders Co.).

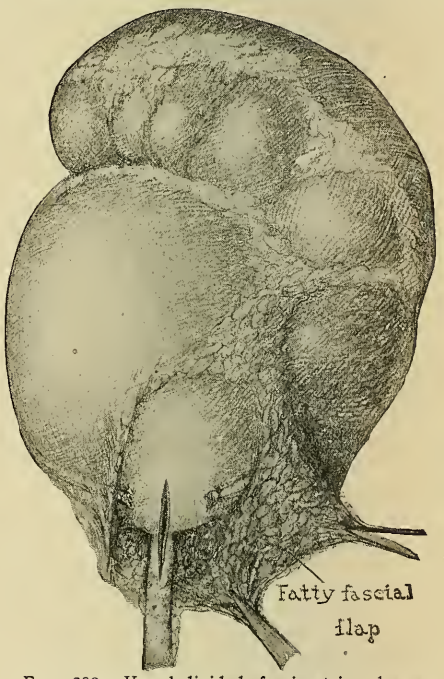


FIG. 289.—Vessel divided, fascia stripped away, and ureteropelvic-juncture incised. (Mayo's Clinics, W. B. Saunders Co.)

ternal urinary meatus, the vagina, a pouch near the bladder, the rectum, the seminal passages, and on the surface of the labium minus.

Valve-formation is an anomaly of serious import, and may be either congenital or acquired; hydronephrosis is frequently the resultant condition. In the congenital form, in place of leaving the renal pelvis by a funnel-shaped orifice at its lowest portion, the ureter may emerge from the side of this sac, often at an acute angle; or it may run for some distance in the wall of the kidney pelvis.

The acquired valve is generally caused by the distorting effect of hydronephrosis upon the renal pelvis, the least supported posterio-inferior portion of which bags downward.

The diagnosis may be established by ureteral catheterization, and ureterography with colloidal silver, in conjunction with the clinical symptomatology.

For the relief of valvular obstruction the kidney pelvis and the upper portion of the abdominal ureter are thoroughly exposed by the lumbar extraperitoneal incision. The ureter is incised below the sac, and a probe passed into the pelvis of the kidney. The valve, or the inner ureteral wall, should the obstruction be caused by the ureter running upward in the pelvic wall, is divided from above downward to the most dependent part of the sac. The resulting longitudinal wound may be closed by drawing its corners together, thus converting it into a transverse wound (Fenger), or by applying numerous fine catgut

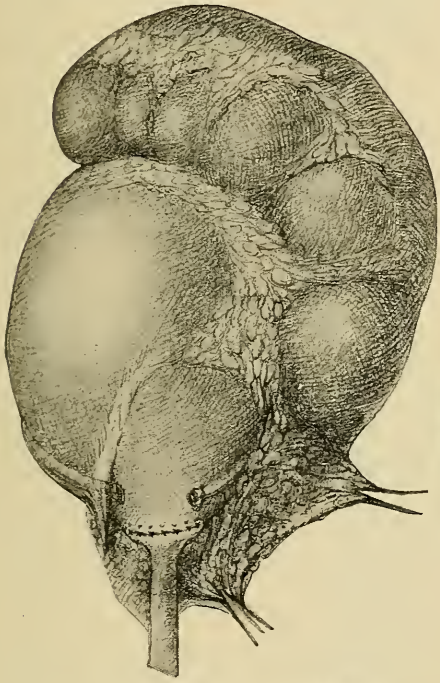


FIG. 290.— Wound sutured transversely. (Mayo's Clinics, W. B. Saunders Co.)

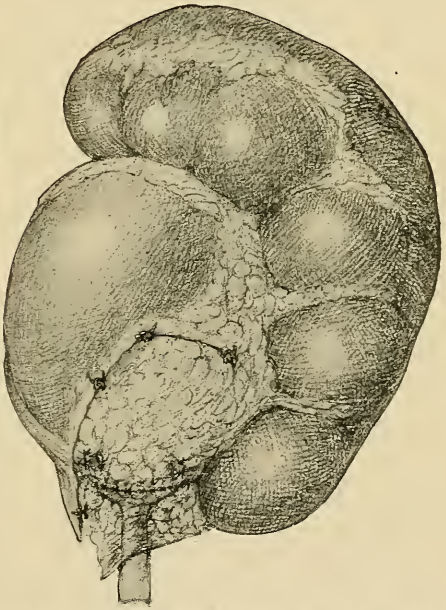


FIG. 291.—Fascial flap sutured over ureteral wound. (Mayo's Clinics, W. B. Saunders Co.)

sutures along the whole course of the incision (Mynter) (Figs. 288, 289, 290, and 291). Plication of the redundant pelvis has been curative, and in at least one case an anastomosis has been made between the pelvis and the bladder. Uretero-ureterostomy may be indicated for the relief of obstructions along the course of the ureter. When the underlying cause of the hydronephrosis and valvular obstruction has been a movable kidney, the organ should be sutured in place.

Kinks of the ureter are usually acquired, but may be congenital. They are commonly the result of movable kidney and cause either intermittent or permanent hydronephrosis. Occasionally they may be caused by ureteral adhesions.

The diagnosis depends upon X-ray ureterography in conjunction with metalized catheters or the injection of colloidal silver.

The treatment lies in removing the cause.

WOUNDS AND RUPTURE OF THE URETERS

Wounds of these canals, except those inflicted during the course of surgical operations, are usually attended by injuries of other organs immediately threatening to life. The ureter may be wounded by direct violence, as by a stab or a bullet, or may be ruptured by indirect violence, as by a crush or a blow. In the course of hysterectomy division of the ureter is comparatively common.

As a result of rupture of the ureter there is extravasation of urine. If this be sterile it does not necessarily excite cellulitis, and in case the ureter is not completely torn across the opening may cicatrize and the extravasated urine may be absorbed or become encapsulated, in the latter case producing the condition known as pseudo-hydronephrosis. If there is concomitant infection cellulitis will result, which, unless promptly recognized and treated surgically, spreads rapidly and may terminate fatally. Following cicatrization of wounds strictures may be formed causing hydronephrosis, and, finally, total destruction of the kidney.

When after a blow in the lumbar region there is passage of bloody urine with the formation of a post-peritoneal tumor which fluctuates and rapidly and progressively increases, rupture of the ureter or kidney may be suspected. A positive diagnosis is usually possible by the X-ray after the injection of colloidal silver through a ureteral catheter, but the method is not without danger. When, some weeks or months after injury to the ureteral region, symptoms of hydronephrosis develop, these symptoms suggest partial laceration of the ureter followed by cicatricial contraction.

Wounds of the ureter inflicted during the course of intra-abdominal operations are usually recognized, because the white, fibrous, thick-walled canal is easily identified, and because there will probably be escape of urine into the wound.

Accidental ligation of a single ureter causes typical renal colic, or no symptoms at all, followed, if the condition be unrelieved, by atrophy of the corresponding kidney, provided it be normal; by acute pyelonephritis if the kidney be infected.

Treatment.—When symptoms point to rupture of the ureter without external wound, there should be no hesitation in making an extraperitoneal approach to the seat of the rupture, draining the tissues of the extravasated urine, and restoring the continuity of the canal. When there is an external wound through which the urine escapes, this wound should be followed down to the ureter.

If the wound communicates with the peritoneal cavity, the incision of choice is an abdominal one; after closure of the ureteral opening the peritoneum is brought together over the line of suture. Drainage should be inserted extraperitoneally down to the wound in the ureter; abdominal drainage should also be employed for a few days.

Extraperitoneal wounds, if longitudinal, do not require suture, since they heal without subsequently encroaching upon the lumen of the canal. If transverse and involving half of the lumen of the ureter, even though they

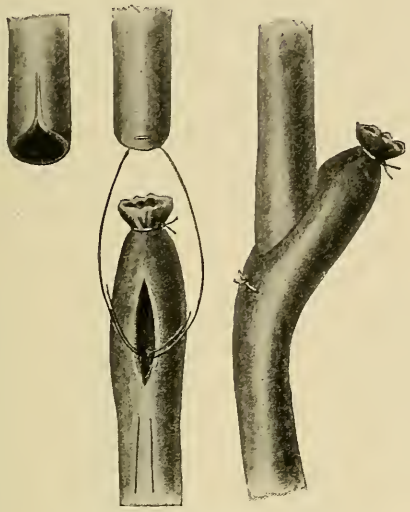


FIG. 292.—End-in-side anastomosis. (Van Hook.)

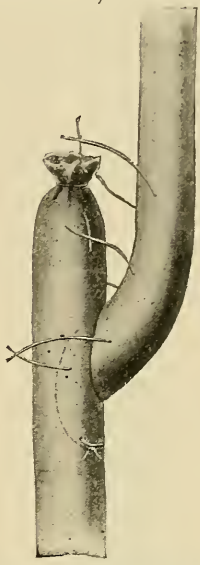


FIG. 293.—End-in side anastomosis, with reinforcing sutures.

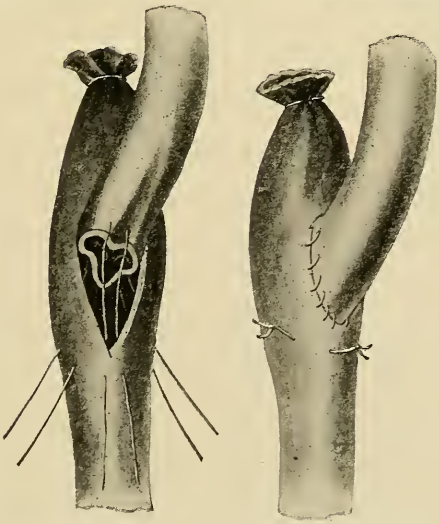


FIG. 294.—End-in-side anastomosis. (Emmet).

be sutured and unite by first intention, there is likely to be cicatricial contraction which will ultimately cause stricture.

Transverse wounds may be treated by making from the middle of the transverse cut incisions upward and downward through the ureteral walls for

a sufficient distance; the four corners formed by these cross-cuts are trimmed off, and the resulting wound is united transversely by folding the ureter on itself. (Fenger.)

Complete division of the ureter may be treated by end-in-side, end-to-end, or end-in-end suture. End-in-side (Van Hook's method) ureteral implantation is thus performed: The lower end of the ureter is ligated from one-eighth to one-fourth of an inch from its free end. With a sharp-pointed scissors a longitudinal cut is made in the lower end of the ureter, twice as long as its diameter, one-fourth of an inch below the ligature. The upper end of the ureter is split by passing a point of the scissors one-fourth of an inch within its lumen and cutting through the wall. Two very small needles, placed on each end of a catgut suture, are then passed through the wall of

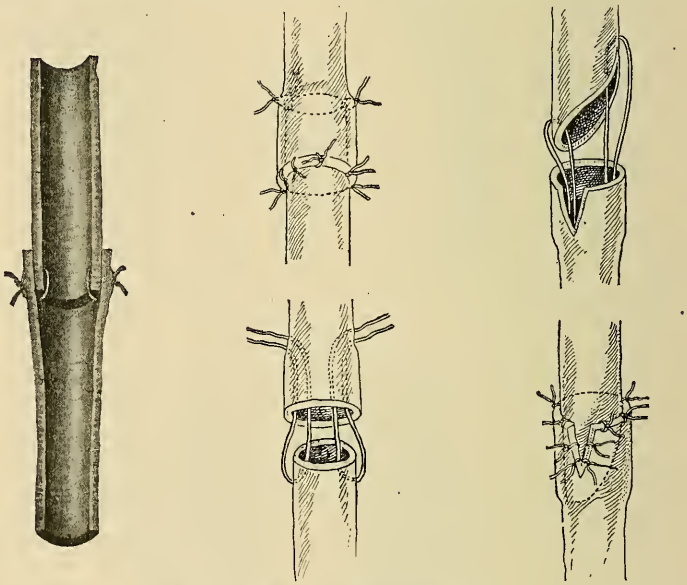


FIG. 295.—End-in-end anastomosis.

the upper ureteral end one-eighth of an inch from its extremity; the needle-punctures are made from one-sixteenth to one-eighth of an inch apart, and are equally distant from the end of the ureter (Fig. 292). The needles are then carried through the slit in the side of the lower end of the ureter and along the lumen of the canal for half an inch; at this point they are pushed through the ureteral wall side by side. Traction upon the catgut suture will pull the upper ureteral extremity into the slit made in the lower extremity. When this has been done the ends of the loop are securely tied (Fig. 292). If this operation has been done through the peritoneal cavity it should be completed by covering the seat of suture by a double layer of peritoneum. The implantation may be strengthened by one or two sutures securing the wall of the proximal ureteral end to the margins of the longitudinal incision made in the distal end (Fig. 293).

In case of dilatation of the upper end to be united, Emmet suggests puckering this end by three sutures to draw the upper end in place (Fig. 294).

When there is insufficient tissue to perform an end-in-side anastomosis, an end-in-end or end-to-end anastomosis should be effected. The methods of performing these operations are indicated in Figs. 295 and 296.

All of the methods described have given good results. The ureter, on account of its very free blood supply, is well adapted to the performance of plastic operations. All sutures which enter the lumen of the canal should be of catgut to avoid the formation of fistulæ or incrustations; sutures which are placed entirely in the outer coats should be of silk.

When the ureter is torn across, and so much of it is destroyed that ureteral anastomosis is not possible, it should be implanted into the bladder, if this is practicable, by either the extraperitoneal or the intraperitoneal route; the latter is usually the only feasible method of performing the operation.

FIG. 296.—Oblique end-to-end anastomosis.

VESICAL IMPLANTATION.—Payne's successful method is performed by passing a sound through the urethra, and by means of the tip causing the wall of the emptied bladder to project at a point as near the trigone as the conditions will allow. A short antero-posterior incision is made on the point of the sound. The divided end of the ureter is then split for a short distance on each side, and is carried into the bladder for some distance by means of mattress sutures passed through the flaps, then through the bladder wound, and out through the bladder-wall, to be tied on the peritoneal surface (see Figs. 297 and 298). Additional sutures are inserted about the anastomosis to unite the serous and muscular coats of the bladder to the ureter. Finally a loose fold of peritoneum or omentum is fastened around the utero-vesical anastomosis. This fold, designed to prevent leakage and add strength to the junction, must not be drawn tight enough to cause constriction. The distal portion of the divided ureter should be ligated, the cross-section above the ligature being cauterized with pure carbolic acid. Drainage is not required.

When the ureter is too short to easily reach the bladder downward, dislocation of the kidney has been resorted to, to make an anastomosis possible.

If the ureteral defect is so far removed from the bladder that neither vesical implantation nor ureteral juncture is possible, the two ends may be brought to the surface, as proposed by Rydygier, and an effort made to connect them by forming a channel of skin. Or the ureter may be implanted upon the skin surface. Implantation into the colon is difficult, and in the light of present evidence may be expected practically always to be followed by kidney infection. Colonic implantation is attended by a heavy mortality (sixty-one per cent., Keyes), ascending infection being common even when the ureters are made to traverse the walls of the bowel obliquely and their orifices are protected by tongue-shaped flaps of mucous membrane.

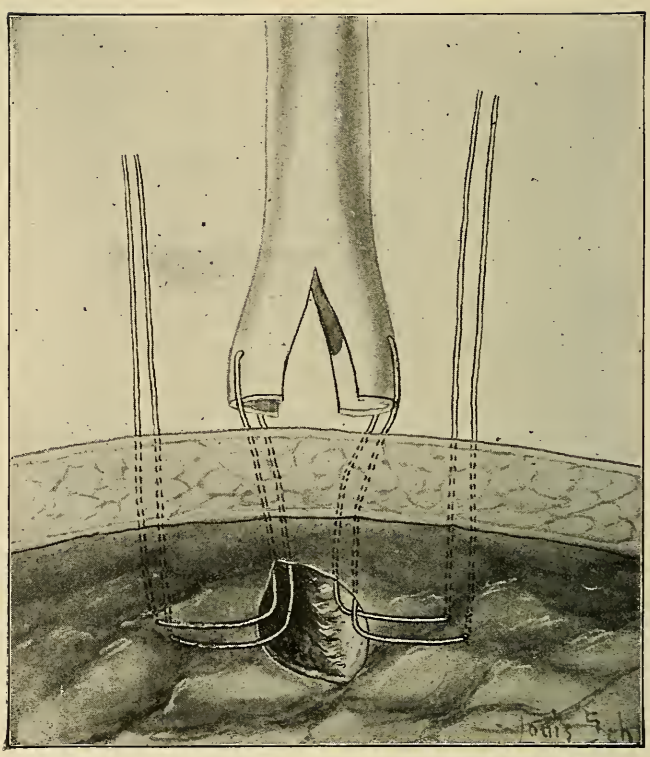


FIG. 297.—Method of drawing ureter through bladder-wall. (Payne.)
(Journal American Medical Association, October 18, 1908.)

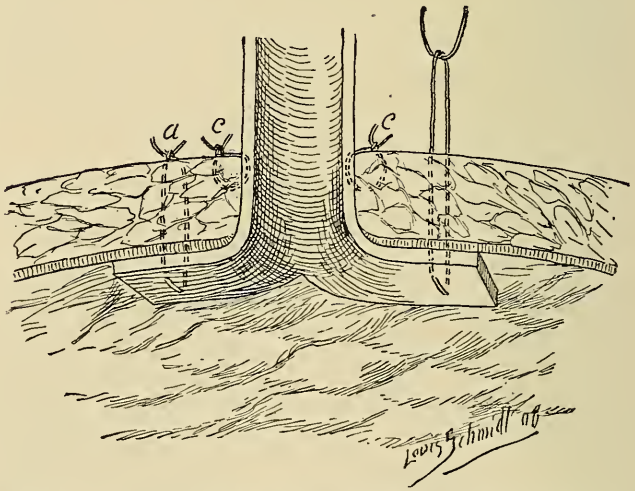


FIG. 298.—Cross-section of anastomosis complete: *a*, traction suture tied *c*, vesico-ureteral sutures tied. (Payne).

Implantation into the skin commonly gives unsatisfactory drainage. The operation of choice when the opposite kidney is known to be functionally sufficient is nephrectomy; when the renal function has not been determined, or is known to be deficient, a nephrostomy should be performed.

URETERITIS

Infection extends from the bladder, as in gonorrhœa, from the kidney, as in pyonephrosis of hæmatogenous origin or tuberculosis, or from peri-ureteric tissues, as in appendicitis or perinephric abscess. Congestion strongly predisposes to infection, and is caused by traumatism, pressure of tumors, distention of the ureters, lodgement or passage of calculus or clot, or the passage of irritating urine.

The lesions produced by ureteritis are similar to those observed in cystitis. In the absence of distinct glands in this part of the urinary tract, complications akin to folliculitis and periurethral abscess observed in urethritis are not likely to occur.

As a result of hyperæmia and inflammatory swelling, it is apparent that the lumen of the ureters may be seriously encroached upon. If the inflammation extends beyond the mucous membrane, involving the muscular coat, there may be resulting atrophy, with loss of peristaltic power. From long-standing inflammation and the deposition of inflammatory material strictures may form.

Jaksch reports a case of membranous ureteritis in which translucent casts of the ureter were discharged from the urine.

Symptoms of ureteritis are not definite. It is nearly always associated with cystitis or pyelitis, the symptoms of which completely mask the inflammation of the ureter. Tenderness on palpation is perhaps the only symptom which would even suggest inflammation. In the urine there may be found masses of squamous epithelium without pus. (Garceau.)

Kelly states that a normal ureter can be traced and immediately examined in the upper part of the pelvic course by introducing a ureteral catheter and carrying it up to or over the brim of the pelvis. When an inflexible catheter is thus carried over the brim the ureter is displaced upward and straightened out, and can be palpated through the rectum, and any alterations in its calibre noted almost as minutely as when laid bare by dissection.

The palpation of the ureter through the abdominal wall for the purpose of detecting tenderness is sometimes practicable, pressure being made at the intersection of the line joining the anterior superior iliac spines with one vertical to this running upward from the junction of the inner and middle thirds of Poupart's ligament. Clinical experience has shown, however, that even extreme tenderness elicited by deep pressure over this part is not pathognomonic of ureteritis.

Treatment.—The treatment of ureteritis is that of the main disease which masks it. Instillations and irrigations such as are used in the treatment of cystitis are serviceable.

STRICTURE OF THE URETER

This may be congenital or acquired. The acquired stricture may be inflammatory or traumatic. Congenital stricture has been regarded as the commonest form of narrowing. Tuffier reports twenty-nine cases. In fifteen the narrowing was in the upper part of the ureter; in the remainder it was in the lower part.

Inflammatory stricture is apparently more common than pathological records would lead us to believe, and is usually multiple. Watson has reported two cases.

Traumatic strictures are necessarily rare, since there are comparatively few cases of ureteral wound.

The symptoms of ureteral stricture are those of back pressure. Should the stricture produce complete obliteration of the ureter, the kidney will atrophy. Partial occlusion causes hydronephrosis and great dilatation of the ureter above the seat of narrowing.

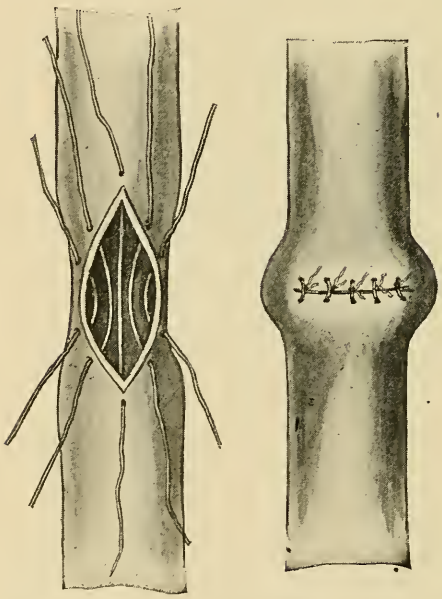


FIG. 299.—Operation of ureteroplasty for stricture.

The diagnosis of ureteral stricture is founded upon the development of hydronephrosis, and direct exploration of the ureter by means of catheters or bougies, and by radiography. Cystoscopic examination shows an abnormal condition of the ureteral orifice and the surrounding mucous membrane. The ureteral catheter is arrested at the seat of narrowing; when after persistent pressure it has passed through there is a continuous flow of urine. Injection of fluid, since it results in sudden increase of renal tension, causes pain, the coarctation preventing the fluid from passing into the bladder between the catheter and the ureteral walls. As the instrument is withdrawn, its tip is felt to slip from the grasp of the stricture.

The prognosis of ureteral stricture is grave because of the usually associated renal involvement. The condition is rarely suspected till pyelitis, hydronephrosis, or pyonephrosis develops. Strictures of the lower segment are more easily cured than higher ones; those due to periureteral contracture recur even when fully dilated.

Treatment.—A permeable stricture may be treated by (1) intermittent dilatation, beginning with a bougie or catheter one millimetre in diameter and increasing to four millimetres; the treatments being practised twice a week, and being preceded by vesical irrigations and followed by ureteral irrigations of boric acid 1 to 100 or protargol 1 to 3000. (2) Continuous dilatation, the catheter being left in place for one or two days and then changed to a larger instrument until full dilatation is reached.

When the stricture is not pervious from the bladder, or when it is im-

possible to pass an instrument into the vesical end of the ureter, the narrowing may be attacked from above. These cases are always complicated by hydronephrosis; hence it is easy to enter the pelvis of the kidney through its posterior wall. If the ureteral orifice of the pelvis cannot be found, the ureter can be exposed slightly below this point, opened by a longitudinal incision, and explored above and below by bougies ranging in size from No. 4 to No. 12 French. If the stricture is not amenable to dilatation (traumatic), it may be treated by longitudinal incision and transverse union of the resulting wound (Fig. 299), or by excision and the restoration of the continuity of the ureter by uretero-ureterostomy. If none of these procedures are practicable, the ureter may be divided and implanted into the bladder or on the skin surface, or the kidney and ureter may be excised. The last operation is indicated in cases of unilateral tuberculous stricture.

Küster, finding obliteration of the ureter three centimetres below the pelvis of the kidney, resected three centimetres of the ureter, including the strictured portion, and fastened the distal end to the lower part of the renal pelvis. The patient was cured.

After having found one stricture, the ureter should always be sounded to determine the presence or absence of others.

CALCULUS OF THE URETER

The great majority of kidney-stones either remain lodged in or near the pelvis or, having once entered the ureter, pass into the bladder. This passage

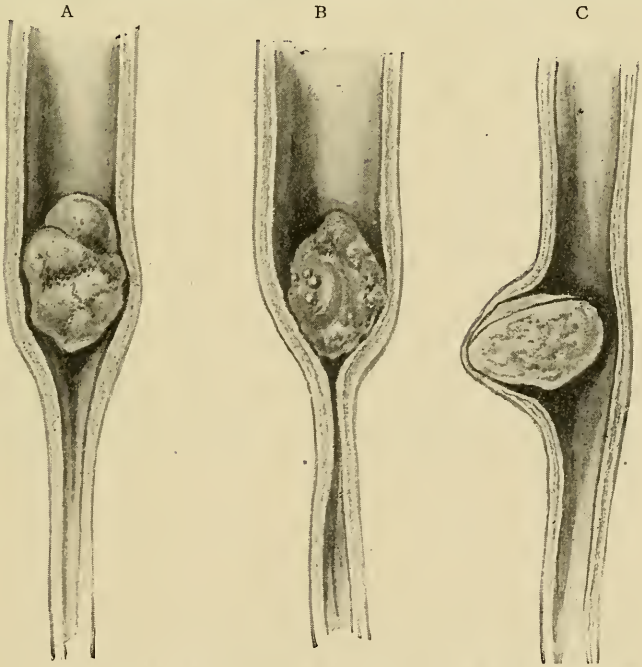


FIG. 300.—Ureteral calculi. A, ball valve, permitting intermittent flow of urine; B, impacted, causing complete blockage, with resultant atrophy and atresia of ureter below; C, sacculated stone, permitting passage of urine and the introduction of a catheter.

is often attended by no symptoms. When the stone is of such size and shape that it is arrested in its passage, thus blocking the ureter, a nephritic colic develops. Schenck and Tenney note that of one hundred and thirty-four cases of ureteral calculi seventy-four were in females and fifty-eight in males. The points of impaction correspond to the points of narrowing of the canal (see p. 560). About one-quarter are lodged at the first point of narrowing. A few more than one-eighth are caught at the middle constriction, and over half of all ureteral calculi become impacted just above the bladder. They may lodge in the intravesical or even in the intramural portion. A single calculus is the rule (Fig. 300), but in about one-eighth of the cases they are multiple (Figs. 301 and 302).

FIG. 301.—Multiple calculi of the ureter. (From Laboratory of Surgical-Pathology, University of Pennsylvania.)

Symptoms.—The prodromal symptoms of calculus in the ureter may be those of renal calculus (see p. 621) or the passage of gravel and small concrements with the urine. Often the attack comes on without prodromal symptoms. The patient is seized suddenly with an agonizing pain radiating over the lumbar and hypochondriac regions, along the course of the ureter, to the end of the penis, to the testicle of the affected side, and to the inner surface of the thigh. The pain is usually continuous, with exacerbations. It may be felt in the belly, small of the back, or sacrum; very exceptionally it is referred to the chest. The suffering is so severe that the patient becomes blanched, bathed in cold sweat, and sometimes collapses. There is often reflex vomiting. The testicle of the affected side is usually drawn close up to the external ring, and the abdomen may become tender and tympanitic; if there has been no infection of the kidney pelvis, fever rarely develops. There is often a constant distressing desire to urinate, with loss of power to empty the bladder. There may be anuria due to reflex disturbance of the healthy kidney, perhaps more frequently attributable to the fact that the patient is possessed of but one secreting kidney, the duct of which is blocked.

Pain may be referred to the healthy kidney. Neuman has reported three cases of this crossed renal pain, in two of which calculi and in one pyonephrosis were found on the side opposite that which gave the subjective symptoms.

The pain and reflex disturbances are due to retention of urine in the kidney pelvis and the upper segment of the ureter. For a time this retention may be absolute, since the irritation and congestion incident to the arrest of the stone occasion swelling and spasm which are sufficient, together with the foreign body, to close entirely the ureteral lumen. These symptoms may last a few minutes, a few hours, or several days, and their subsidence may be as sudden as their onset. This sudden complete subsidence indicates either retrogression of the stone into the kidney pelvis or its extrusion into the bladder-

cavity. The symptoms may subside gradually, recurring at intervals, and may be followed by the gradual development of hydronephrosis. This indicates that the stone has been lodged in the ureter, and that the first absolute obstruction has yielded, partly to dilatation of the foreign body, partly

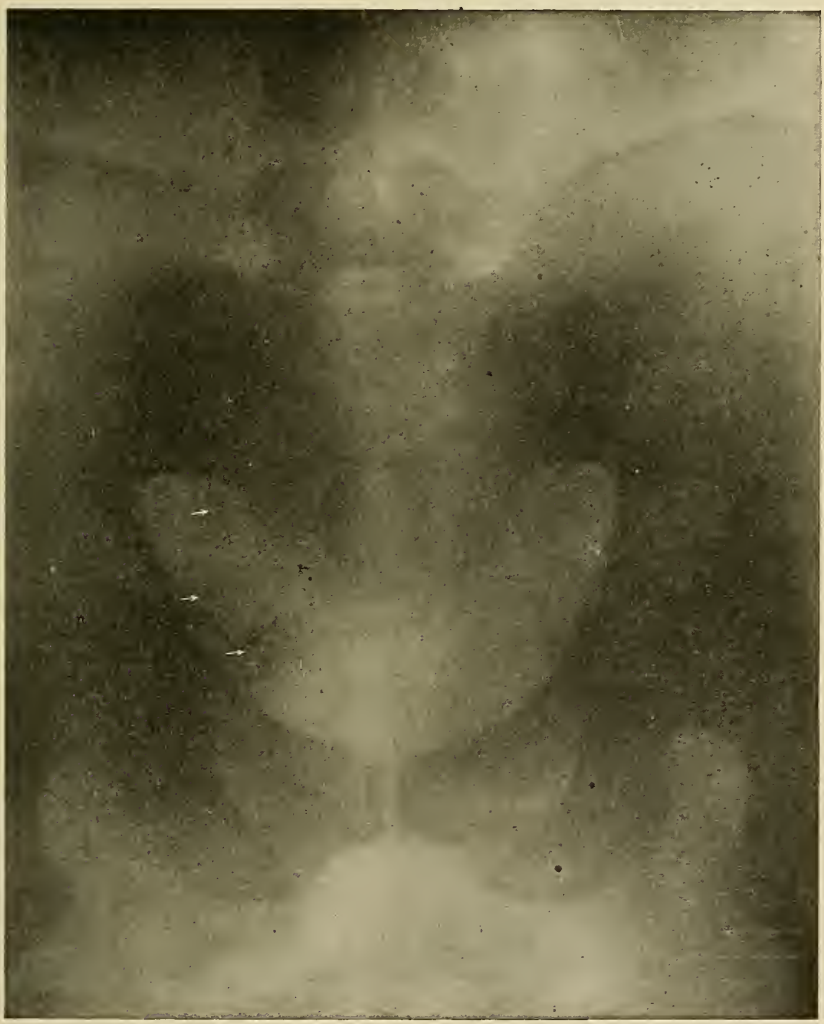


FIG. 302.—Multiple ureteral calculi. (Skiagram by Dr. H. K. Pancoast.)

to relaxation of the spasm, and has allowed a portion of the urine to pass through. Under these circumstances kidney colic is liable to recur, but with less severity.

During an attack of colic the urine may be absolutely normal. This points to the existence of one healthy kidney. If blood is found, it may be taken as an evidence that the obstruction is not complete, provided there is no

reason to believe that the hemorrhage comes from the kidney or the ureter of the unaffected side. Immediately on the subsidence of the attack a small quantity of blood is constantly found in the urine.

Diagnosis.—The diagnosis of impacted ureteral stone is based on a history of the symptoms of kidney calculus (see p. 621) and of one or more attacks of colic, followed by the development of hydronephrosis (Fig. 303), pyonephrosis, or pyelonephritis. The X-ray will often demonstrate both the seat and the number of ureteral calculi. When the shadows are not placed

FIG. 303.—Calculus in pelvic ureter. A collargol skiagram demonstrating a hydroureter and hydronephrosis of the right side due to a calculus impacted in the lower end of the ureter. The calculus was pushed up the ureter about three inches when the catheter was introduced. Seventy cubic centimetres of ten per cent. collargol were injected on the right side before pain was produced; on the left side but ten cubic centimetres could be injected. Indigocarmin was eliminated on the left side in sixteen minutes; on the right side not, for over twenty minutes. (Skiagram by Dr. H. K. Pancoast.)

along the normal course of the ureters, the presence of phleboliths or calcareous lymph-nodes should be suspected. For the positive differentiation of ureteral calculi and phleboliths it is often necessary to make the radiogram with a radiographic catheter in the ureter; in such cases it is best to make stereoscopic plates, lest a phlebolith lie directly in line with the catheter.

Palpation either through the rectum or through the abdominal walls, ureteral catheterization, and the X-ray may enable the surgeon to form a positive opinion as to the presence of ureteral calculus; but it must be confessed that often all diagnostic means fail. Thus, a clear history may be wanting, the patient perhaps having severe abdominal pain, which is attributed possibly to gall-stones or to some other intra-abdominal trouble. If the stone completely blocks the ureter, in place of hydronephrosis the kidney may atrophy exactly as it would do if a ligature were applied about the ureter. In fat subjects it is difficult to develop a satisfactory skiagram.

Diagnosis founded on kidney colic is usually fairly reliable, since this pain is highly characteristic. Yet it must be remembered that stone in the ureter has been diagnosed when the real condition was passage of a gall-stone, appendicitis, neuritis of the lumbar nerves, spinal caries, or acute intestinal obstruction.

Careful, repeated examinations of the urine will usually enable the surgeon to determine whether or not the symptoms are due to blocking of the ureter. Moreover, the conditions with which ureteral calculus may be confounded have usually certain pathognomonic features which sooner or later manifest themselves. Thus, gall-stone is attended with jaundice, and the pain is likely to be referred to the region of the right shoulder. Appendicitis exhibits increasing tenderness on pressure over McBurney's point, the abdominal symptoms become rapidly and progressively worse, and blood and pus are not found in the urine. In neuritis of the lumbar nerves the tenderness is superficial, and there is no marked change either in the quantity of urine passed or in its constituents. The persistent vomiting of intestinal obstruction, shortly becoming fæcal, and the obstinate constipation, would suggest the nature of the affection.

As the symptoms are due to obstruction, and not to the irritation caused by the rough corners of a stone, they will be as distinctly marked if the obstruction is due to a portion of tumor, a blood-clot, or a mass of inspissated tuberculous pus. The diagnosis as to the cause of the obstruction is dependent on the previous history of the patient.

Intermittent pyuria—that is, the passage of normal urine during attacks of colic, the passage of pus in the urine during intervals—points to the existence of one healthy kidney. The blocking during the acute attacks is complete, hence no pus escapes into the bladder; during the intervals, owing to relaxation of spasm or lessened congestion, part of the urine escapes on the diseased side, carrying with it pus.

Palpation will fail certainly in a large majority of cases. It may, however, show a point of tenderness, which if constant is a sign of some value in locating the stone. If the calculus is lodged near the vesical orifice of the ureter, it may readily be felt in women. In men this is more difficult, since the examining finger per rectum can rarely be extended as far as the posterior

extremity of the seminal vesicles. Ureteral catheterization may succeed in locating the seat of obstruction, and may possibly indicate the presence of stone. In order to demonstrate the fact that the catheter has come in contact with a stone, Kelly has advocated the use of catheters whose ends have been dipped in melted paraffin, and Cunningham and others have devised styletted catheters with devices making the impact of the catheter against the stone audible. As a further means of diagnosis, and one always justifiable when the integrity of the kidney-substance is threatened by the persistence of symptoms, exploration by lumbar incision is valuable. This enables the surgeon to explore directly the entire abdominal ureter, and by means of bougies to determine whether or not the pelvic portion is patulous.

The diagnosis betwen ureteral calculus and blocking of the ureter from unnatural mobility of the kidney is sometimes absolutely impossible except by pyelography (radiography). The symptoms are precisely the same, and in both cases the urine may show blood after the attack is over. A movable kidney would be suggested by the prompt relief which sometimes follows either abdominal manipulation of the organ or the assumption of the dorsal decubitus.

Much valuable information is often obtained by observing the elimination of indigocarmin by the suspected kidney as compared with that of its mate. As ureteral calculi commonly cause deterioration of the renal parenchyma by reason of the back pressure exerted, when other symptoms point to the existence of this condition delayed elimination is strongly corroborative evidence.

The diagnosis of ureteral calculus can rarely be established from a single symptom or sign, but with the newer methods of examination at our disposal, and the marked improvements in some of the older ones which have been made during the last few years, failure to arrive at a diagnosis by non-operative means is almost as rare.

Prognosis.—The calculus having passed into the ureter may recede into the kidney pelvis, may pass on to the bladder, or may be permanently lodged.

Calculus lodged in the ureter, if it entirely blocks this canal, causes rapid and complete destruction of the secreting substance of the kidney. Provided the other kidney is healthy, it is usually able to function for both. When the obstruction is partial there is back pressure, with more or less dilatation of the ureter, kidney pelvis, and calices, and gradual degeneration of the kidney-substance. The congestion incident to this condition strongly predisposes to infection. As the ureteral walls dilate they commonly become thickened.

The calculus may become sacculated to one side of the ureteral lumen, so that there is little interference to the passage of urine or the ureteral catheter (Fig. 304), or it may ulcerate entirely through the ureteral wall, forming an abscess, which may open externally in the lumbar region, or into the colon, or may follow the course of perinephritic abscesses.

Treatment.—Since most stones which enter the ureter from the kidney pelvis pass into the bladder, the immediate treatment of either a first agonizing attack of renal colic incident to calculous obstruction of the ureter, or of recurrent mild attacks, should be palliative, measures being promptly taken, however, to determine by X-ray the size and position of the stone. The patient should be given a hot bath, and a full dose of morphine hypodermically. The administration of medicines by the mouth is of little service, since there

is usually vomiting. A hot rectal enema is useful in relieving the tympany, which is sometimes symptomatic of ureteral obstruction. When the pain is so agonizing that it seriously affects the pulse, inhalations of ether should be given until sufficient time has elapsed for the morphine to produce its quieting effect. The urgent desire to micturate, from which patients suffering from kidney colic complain, is a pure reflex. There is usually retention,

FIG. 304.—Calculus sacculated in wall of left ureter. (Skiagram by Dr. H. K. Pancoast.)

probably spasmodic in nature. It is relieved by a hot sitz-bath, the patient being directed to urinate while sitting in the bath. If it should persist, the bladder forming a distinct tumor above the pubis, the catheter should be used with every aseptic precaution, since the conditions for ascending infection are peculiarly favorable during and after the passage of a stone.

When it is evident from the size of the stone as shown by the X-ray, or from the gradual development of a hydronephrosis, or the persistently recurring mild attacks of kidney colic, that a calculus is lodged, and that the kidney is becoming seriously affected; when during an acute attack the secre-

tion of the urine is partly or completely suppressed, suggesting that the patient has not a healthy kidney on which to fall back; or when fever and hectic develop, together with pus in the urine, pointing to pyonephrosis,—surgical interference is imperative.

Calculi lodged in the vesical orifice of the ureter and projecting into the bladder have been removed by the lithotrite or by cystoscopic forceps, or through a vesical opening. Small stones lodged near the lower end of the ureter can sometimes be made to pass by dilating the ureteral orifice by the passage of a Garceau dilating catheter or some other form of ureteral dilator, and injecting sterile olive oil, from five to fifteen cubic centimetres, about the stone. In women calculi frequently lodge in the portion of the ureter lying within the folds of the broad ligament, because of narrowing incident to disease of the structure. An incision through the anterior vaginal vault upon such a stone, if it be palpable, enables the surgeon to remove it without opening either the peritoneum or the bladder.

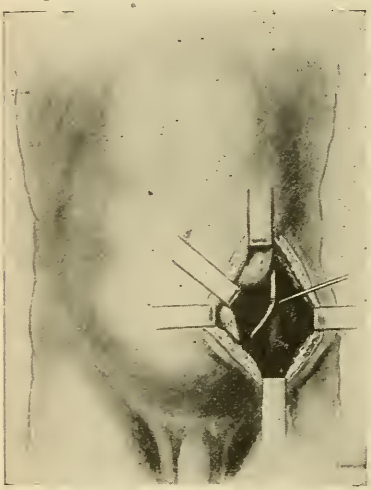


Fig. 305.—Muscle splitting incision for the exposure of the ureter.

The operative approach for the removal of calculi from the ureter varies with the part of the canal in which the stone has lodged, as determined by the ureteral catheter and the X-ray. In the first three or four inches of its course the incision is a slight prolongation of the oblique cut used for the exposure of the kidney. Farther down the ureter is better reached through a muscle-splitting incision: this may be placed at any level below that of the umbilicus, according to the position at which the stone has been halted. The skin cut, about five inches long, is made either in the direction of the fibres of the external oblique, or almost transversely across the body, in the line of skin-cleavage. The muscles are split in the direction of their fibres, being torn rather than cut. The wound thus made is widely separated by means of three or four retractors, and the peritoneum is stripped from the parietes and retracted toward the midline. The ureter is adherent to the peritoneum, so that it is to be searched for upon this membrane, not on the structures of the body-wall, over which it normally lies. When the stone is in the extreme lower end of the ureter it is most convenient, when possible, to work it up the canal with the fingers till it is in a more easily accessible portion. Strands of heavy silk should then be passed about the ureter above and below the stone to prevent its escape, and a longitudinal incision made of sufficient size to effect its delivery. The cut is closed with one or more sutures of fine catgut passed through the fibrous and muscular coats, or, if this is difficult or impossible, the wound may be left open. The wound in the parietes is closed about a cigarette drain passed down to the ureteral incision; the drain is to be removed about the third day after operation (Fig. 305).

Calculi lodged in the pelvic portion of the ureter can be reached through the lower half of the ilio-lumbar incision or through a vertical cut carried

from the insertion of the rectus muscle four inches upward (Witherspoon). The muscle is torn through in the direction of the fibres and the fascia is cut, exposing the peritoneum, which is stripped up from the abdominal wall as far as the ilio-pectineal line. The finger is then passed to the vesical base, pushing upward and inward the lateral false ligament of the bladder, and separating the peritoneum from the pelvic wall as far back as the vas deferens; by following this canal for two inches from its point of crossing the obturator vessels, the ureter will be reached passing behind it. Both these canals strip up with the peritoneum. The ureter may be palpated as far as the brim of the pelvis. The operation is bloodless and leaves a strong abdominal wall.

The mortality of uretero-lithotomy when uncomplicated by anuria, pyelitis, or pyelonephrosis is less than six per cent.

FISTULA OF THE URETER

Fistulæ are secondary to wounds, rupture, or ulceration of the ureters. A longitudinal wound will usually heal spontaneously without the formation of either fistula or stricture; transverse wounds involving half the diameter of the ureter, and particularly when they completely sever it, are followed by fistulæ.

The wounds are usually inflicted during the course of gynæcological operations. Spontaneous fistula—*i.e.,* that due to ulceration—is caused by tuberculous infiltration, malignant growth, calculus, or foreign body; the fistula under such conditions is secondary to partial or complete ureteral obliteration.

A fistula may open on the surface of the body or into the cavity of a neighboring viscus. The surface opening is commonly in the lumbar region; it may be found in the groin or in some portion of the anterior abdominal parietes. Visceral opening is commonly into the uterus or vagina, but may be into the rectum, and very exceptionally into the stomach. The patulous tract is apt to be fairly direct; it may be long and irregular.

Symptoms.—The invariable symptom of ureteral fistula is a continuous or intermittent discharge of urine. Duplay and Reclus state that if the fistula is near the kidney the flow of urine is continuous. If it is low down towards the vesical extremity the flow is intermittent, coming in jets. The urine may remain perfectly clear, showing no admixture of pus or kidney albumen. For diagnostic purposes methylene blue may be given by the mouth.

Diagnosis.—The diagnosis between ureteral and vesical fistulæ can be established by injecting colored fluids into the bladder. Renal fistulæ are fairly direct, and but a slight amount of urine escapes from them if the ureter is pervious. Catheterization of the ureter and injection of colored fluid will sometimes be serviceable in establishing a diagnosis.

Prognosis.—There is little tendency towards spontaneous cure of ureteral fistula. Provided narrowing of the orifice does not take place, the fistula may produce no appreciable effect upon the general health. It often happens that, because of gradual cicatricial formation and encroachment upon the ureteral calibre, hydronephrosis develops. It should be remembered that in case the ureter is entirely divided, the lower extremity becomes atrophic from disuse, thus making an operation for the restoration of the continuity of the channel extremely difficult.

Treatment.—The first requisite of successful treatment is that the ureter shall be restored to its normal calibre. It is possible that this may be accomplished by the use of ureteral bougies or continuous ureteral catheterization practised through the bladder. Usually the ureter is impermeable.

When the fistula opens into the vagina, colpocleisis may be performed. This operation, first practised by Hahn, converts a part of the vagina into an artificial reservoir for the urine. Kelly in one case of uretero-vaginal fistula closed the ureter by suture. When the vesical extremity of the canal is obliterated the ureter may be implanted into the bladder by the intraperitoneal or the extraperitoneal route.

When the fistula involves the abdominal portion of the ureter, direct closure, splitting of the ureter and transverse suture, or excision of the diseased area, followed by ureterostomy, may be indicated. When it is placed high in the ureter, it may be resected, together with a segment of the ureter, and this canal may be sutured to the renal pelvis.

Cure is assured by nephrectomy. This operation has been many times successfully performed. It should, however, be left as a last resort, efforts being made either to restore the continuity of the ureter or to implant it into the bladder.

TUBERCULOSIS OF THE URETER

Tuberculous involvement of the ureter is usually secondary to tuberculous disease of the bladder or the kidney. The infiltration attacking a portion of the ureter and partially or completely obliterating it may produce dilatation of the segment above, and hydronephrosis or pyonephrosis; or the entire ureter may be infiltrated, becoming a dense, often nodular, impervious cord.

The symptoms of tuberculous infiltration of the ureter are usually completely masked by those of vesical or renal disease. In women palpation of the lower extremity of the ureter through the vaginal vault may show characteristic induration and nodulation, and in thin individuals the tube can sometimes be felt as it passes over the pelvic brim as an indurated cord the size of a lead-pencil. In both sexes attempts at ureteral catheterization demonstrate points of narrowing; the ureteral orifices are rigid, the so-called "golf-hole" type.

The treatment of ureteral tuberculosis cannot be formulated, since this is never encountered clinically as an isolated lesion. If in the course of nephrectomy for tuberculous kidney the ureter is found involved, it should be removed with the kidney (see p. 658).

TUMORS OF THE URETER

Primary tumors of the ureter are less common than secondary growths, the mother-growths of which lie in the kidney pelvis or, in occasional instances, in the bladder. Cysts, fibromata, and myomata have been reported; papillomata, benign from a pathological standpoint, but clinically malignant, have been most frequently encountered; instances of primary carcinoma and sarcoma have been noted, and many cases of secondary carcinomatous involvement are on record.

Hydronephrosis and pyonephrosis are frequent complications. Metastasis may take place to the bladder, kidney, liver, retroperitoneal lymph-nodes, or pleura.

Symptoms.—These are not distinctive. Blood has been present in about eighty per cent. of cases and is often the first symptom; pain and the presence of a demonstrable tumor are present in about sixty to seventy per cent. of cases, the pain being that of ureteral obstruction.

Occasionally the growth protrudes into the bladder from the ureteral orifice, or fragments are detached and recovered from the urine. It is only in such cases that a positive diagnosis is possible.

Treatment.—Nephro-urectomy is the only operation to be considered. In some cases it is necessary to include a portion of the bladder in the resection.

PROLAPSE OF THE URETER

has been reported by Caile in a child two weeks old. There are nineteen reported cases, two of whom were operated on, with one death. (Young.) A sac which was supposed to be a vesical diverticulum presented at the urethral orifice. It was found to be a prolapsed ureter dragged down by a papillomatous growth.

Two cases of URETERAL CYST caused by psorosperms have been reported, one by Eve; the only symptom was profuse hæmaturia, which was not attributed to the cystic formation.

CHAPTER XXVI

SURGERY OF THE KIDNEYS

SURGICAL ANATOMY

The kidneys are situated in the hypochondriac regions on either side of the vertebral column behind the peritoneum. (Plate IX.) The right kidney is a little lower than the left (three-quarters of an inch), probably because of the superimposed liver. The left kidney extends from the level of the interval between the eleventh and twelfth ribs, near the spine, to the level of the third lumbar spine. Each organ is inclined forward and inward, so that their upper portions converge. The outer borders face upward and backward, the inner downward and forward.

The kidneys are fixed in position by a series of short blood-vessels, the parietal peritoneum, the pressure of the abdominal viscera, and a fibro-lipomatous sheath called the renal fascia. This fascia is formed by a splitting of the subperitoneal connective tissue. It encloses the kidney in a pocket opening below and passes inward as a single layer to cover the great blood-vessels. During fœtal life this investment is purely fibrous; later there is an abundant deposit of fat, to which the name of fatty capsule has been given. The deposit of fat is most marked on the outer borders and posterior surfaces of the kidneys. It may be one or two inches in thickness, and serves to fix the organs in a soft nidus.

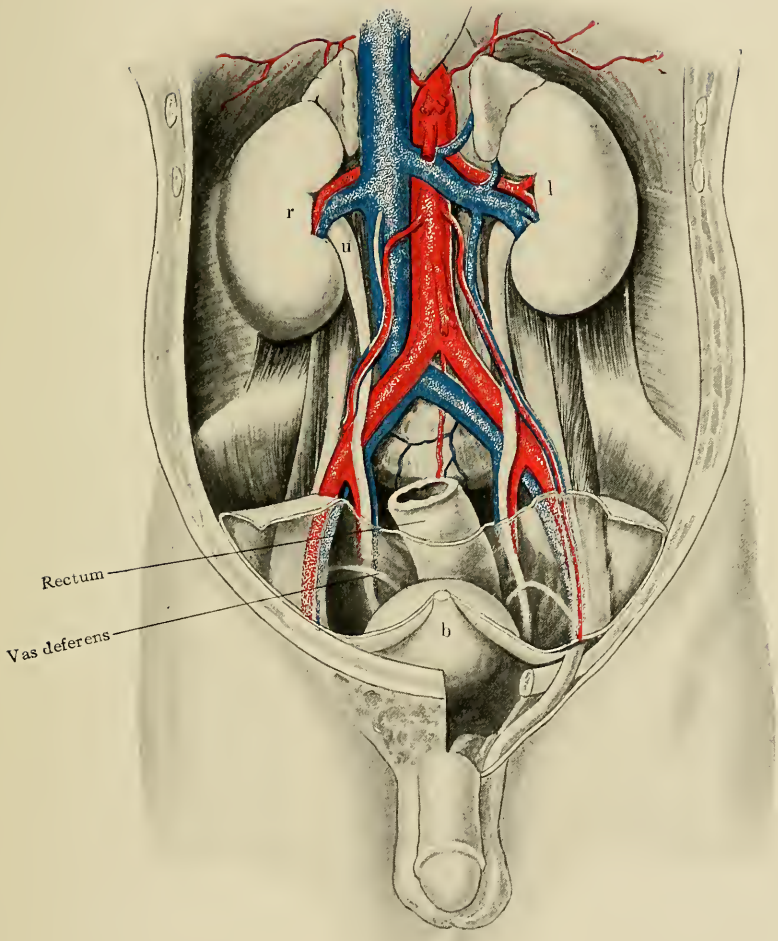
The kidney of average size is four and a half inches long, two and a half inches broad, and one and a half inches thick. It weighs about four and a half ounces. The left kidney is often slightly larger than the right. The kidneys of women are about half an ounce lighter than those of men.

It is irregularly oval in shape, with a convex outer border and a concave inner border. It is ordinarily of brownish-red color, but this is subject to marked variations, depending upon the degree of congestion and the presence of degenerations. It is fairly firm in consistence. The anterior surface of the kidney, turned forward and slightly outward, is covered by peritoneum in its lower portion. The upper extremities of both kidneys are capped by the suprarenal bodies.

The liver lies in front of the upper two-thirds of the right kidney, and is often attached to it by a peritoneal fold called the hepatorenal ligament. Its lower third is in relation with the ascending colon, which lies in direct contact with it, the beginning of the transverse colon, and the second portion of the duodenum, which descends vertically along the inner portion of the anterior surface, crossing the renal vessels and their bifurcations at a right angle. The inferior vena cava obliquely crosses the extreme upper portion of the right kidney. (Testut.)

The anterior surface of the left kidney is in relation with the tail of the

PLATE IX.



Position and relation of the kidneys and other retroperitoneal structures.
r. and *l*. Right and left kidney. *u*. Right ureter. *b*. Bladder.

pancreas, which rests upon its upper fourth, with the spleen lying above and externally, and the stomach below. The terminal portion of the transverse colon and the upper portion of the descending colon lie directly in contact with its lower half or two-thirds, connected to it by loose areolar tissue, unless there be a distinct mesocolon.

The comparatively flat posterior kidney surface faces backward and inward. Behind it lie the diaphragm, the quadratus lumborum muscle, from which it is separated by the anterior layer of the lumbar fascia, and the intercostal and lumbar nerves, and to the inner side of the psoas muscle. Externally it extends beyond the quadratus lumborum muscle, and is then in relation with the transversalis. The posterior kidney surface is entirely free from peritoneal investment, except in the anomalous condition characterized by the presence of a mesonephron.

The diaphragm immediately behind the upper posterior surface of the kidney is extremely thin, and presents a triangular opening, allowing the kidney to lie in almost immediate contact with the pleura. This opening explains the frequency with which abscesses burrow into the pleura. The outer convex border of the kidney is in relation with the spleen and descending colon on the left side, the liver on the right side. The inner concave border, resting on the psoas muscles, presents a fissure termed the hilum, the point of entrance and exit of the blood-vessels and ureter; it is about two inches from the median line of the body, and is about one and a half inches in depth. The important structures coming off from it are the veins, placed anteriorly, the arteries, behind the veins, and the pelvis and ureter, posteriorly. The renal arteries and veins are on a level with the space between the spines of the first and second lumbar vertebræ. The hilum extends to a considerable depth within the substance of the kidney, forming a central cavity known as the sinus.

The kidney is enclosed in a proper capsule of fibrous tissue, beneath which lies an investment of unstriped muscle. The solid part of the organ is composed of the cortical layer, containing the Malpighian glomeruli, which are the beginnings of the uriniferous tubules, and the medullary layer, containing the straight and spiral portions of the uriniferous tubules, as well as the collecting tubules. These collecting tubules are arranged ir separate pyramidal masses, the pyramids of Malpighi, the apices of which form papillæ projecting into the sinus (Fig. 306). They are separated from each other by the cortical substance, which envelops them on all sides, except in the region of the papillæ. The papillæ project into the calyces or infundibula, which are small diverticula into which the ureter subdivides. When the ureter reaches the sinus, having passed in by the hilum, it dilates into a funnel-shaped sac, called the pelvis. From this sac pass a few major channels, each of which divides into several smaller ones, the calyces, these in turn terminating about the openings of the papillæ (Fig. 307). Usually the calyces are as numerous as the papillæ; sometimes two papillæ open into a single tubule. The number of calyces is usually from eight to twelve. Each is about two-fifths of an inch long, and is in calibre No. 6 to No. 10 F. Several of these small canals unite to form a series of three or four larger canals, which open into the pelvis of the kidney (Fig. 307). There are usually three of these large branchings

of the pelvis,—an upper, a median, and a lower. They vary greatly in length and calibre. The pelvis, which receives the urine from the calyces, is about an inch high and not quite an inch wide, and runs directly into the ureter (Fig. 307). Sometimes the junction of these two channels is marked by a slight constriction. The pelvis is placed within the sinus, but extends inward beyond the limits of this opening. In front of it lie the vessels; behind it lies the posterior renal artery, when this vessel is present. The portions which extend beyond the kidney have the peritoneum and the fatty capsule in front, the psoas muscle posteriorly. The duodenum is in relation with the anterior surface of the right pelvis.

The arteries of the kidneys divide into four or five branches, which enter the

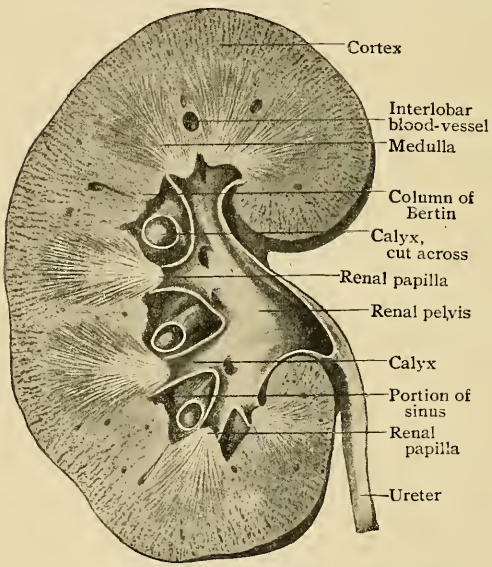


FIG. 306.—Longitudinal section of right kidney, showing relations of pelvis and its divisions to renal substance and to sinus. (Piersol's Anatomy.)

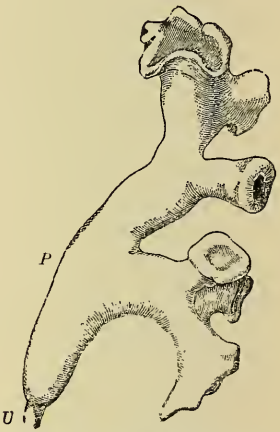


FIG. 307.—Renal pelvis dissected from the pyramids. *P*, pelvis; *U*, ureter. (Henle.)

hilum and lie between the renal vein and the ureter. Within the sinus the branches of the artery run beside the calyces (infundibula) and are embedded in fat. The right renal artery is slightly longer than the left, as it has to cross the vertebral column; for a similar reason the left renal vein is longer than the right. The renal veins leave the kidneys at the hilum, and, passing in front of the renal arteries, empty into the vena cava; the spermatic vein joins the renal vein on the left side.

The blood-supply to the kidneys is particularly abundant. The renal artery may pass as a single vessel to the hilum, or may divide into several branches before reaching this point. These branches are named, according to their distribution, superior, middle, and inferior. The posterior branch passes downward and backward to enter the hilum behind the pelvis.

According to Bonney, there is a variance in the renal arteries and in the arrangement of the constituents of the renal pedicle from that usually de-

scribed in a very considerable percentage of cases. Among fifty-nine bodies examined there were nineteen in which multiple arteries passed from the aorta to one or both kidneys. These vessels usually arose side by side; in a few instances one of the vessels sprang from the region of the bifurcation. The point of entrance into the kidney was usually the hilum or one of the poles, but occasionally the anterior surface or the external border. Among the subjects examined instances were found in which arteries lay in front of the veins, or behind the ureters.

The veins are proportionally as numerous and large as the arteries. In the sinus there are a number of branches, usually lying in front of the arteries; these fuse into the renal vein. This is a short, valveless trunk passing to the vena cava. The perinephric veins are large and numerous and communicate with the blood-vessels of the kidney. Hyrtl has demonstrated that about two-thirds of all kidneys are vascularized by two distinct vascular systems, the vessels as they enter being separated from each other at the renal pelvis. The major vascular tree occupies about three-fifths of the kidney, usually its anterior portion, and the remaining posterior two-fifths is vascularized by the minor system. Normally these two vascular systems are separated in the kidney by a distance of about two millimetres. Upon distention of the pelvis and calyces, however, this separation may be increased considerably. At the plane of separation no large vessels are found and none cross. Anastomoses are not found in the kidney.

The lymphatics pass to the nodes of the lumbar plexus lying near the hilum. The nerves are abundant and supplied with ganglia; they come from the sympathetic system.

Upon careful examination the surface of the kidney is seen to be made up of a number of irregular areas about the size of the end of the thumb. The areas represent the bases of the renal pyramids. They are surrounded by pale lines representing the columns of Bertini extending up between the pyramids and forming support for the blood-vessels. (Sometimes these pale lines are not seen, but in their place may be distinguished groups of stellate vessels.) These small white lines unite a little anteriorly to the convex border of the kidney into a longitudinal slightly depressed white line, appropriately called Brödel's line, which represents the line of division between the anterior and posterior rows of pyramids, the connective tissue of which carries the largest blood-vessels (Fig. 308). The least vascular plane is usually entered by incising the surface of the kidney one centimetre back of this line and cutting toward the pelvis (Fig. 309).

PHYSIOLOGY

The functions of the kidney are the excretion of the urine, and probably the elaboration of an internal secretion.

The excretion of the urine is generally believed to be accomplished in the following manner: Both secretion and filtration participate, the former being the more important. Water and inorganic salts are largely eliminated by the glomeruli. These structures seem to be specially constructed to act as filters, yet it seems probable that even here the epithelial capsule covering the tufts of capillaries has a distinct selective or secretory power. The epithelium of the

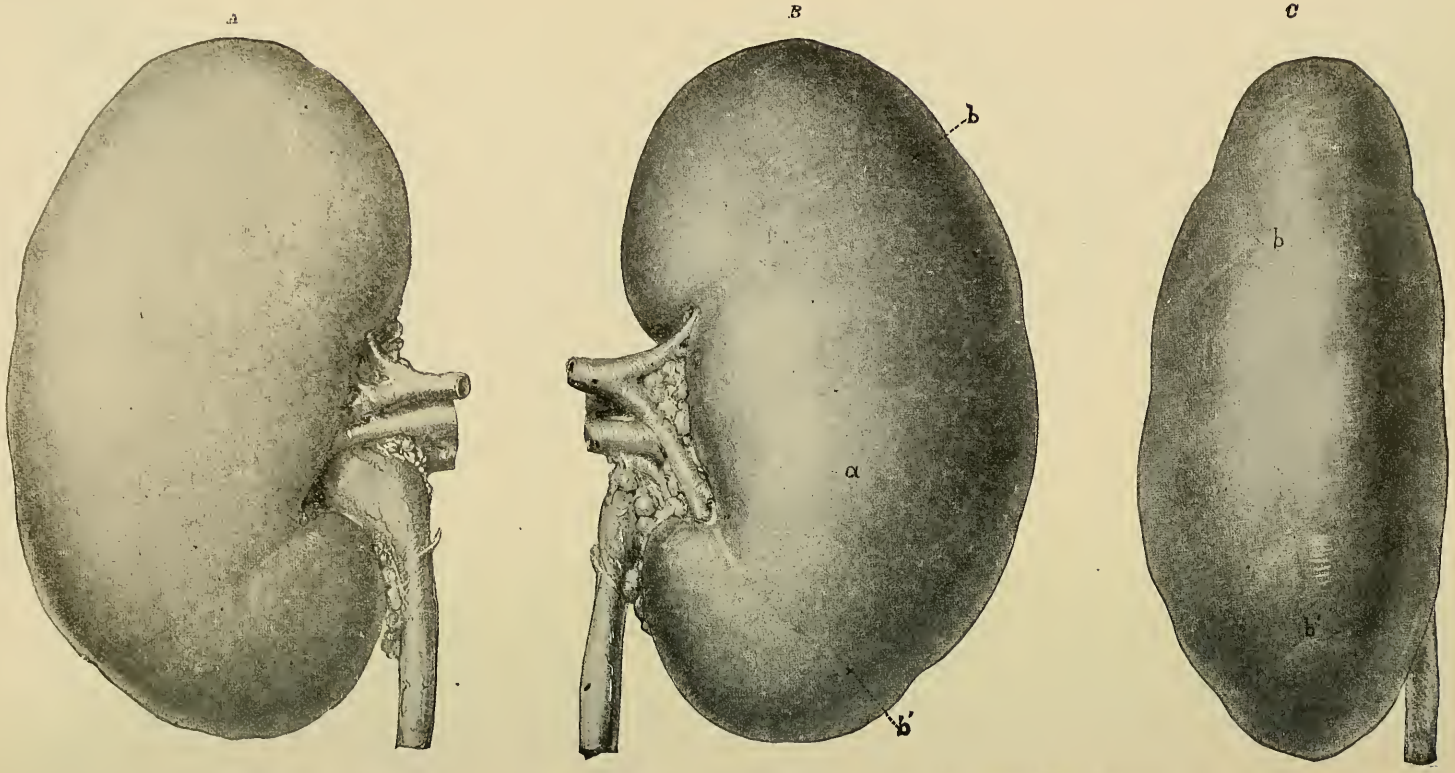


FIG. 308.—Normal kidney. *A*, posterior view; *B*, anterior view; *C*, lateral view; *b-b'*, Brödel's white line. (Brödel.)

convoluted tubules excretes chiefly the organic urinary constituents; it may also have the function of reabsorbing some of the water excreted by the glomeruli. The kidney has the power of excreting bacteria, but by what portions of the organ these are extruded we are ignorant.

No secretory nerves to the kidney have been discovered. There are, however, numerous vasomotor fibres, and the action of these has a marked influence on the activity of the organ; a free passage of blood through the kidney, as when the vessels are dilated, is much more favorable to renal activity than an increment in arterial pressure. Yet in general terms diuresis is favored by an increase in the systemic pressure; it is decreased in collapse, and is abolished when the pressure falls to about 40 mm. of mercury.

Diuretics probably act directly on the renal epithelium, except when their

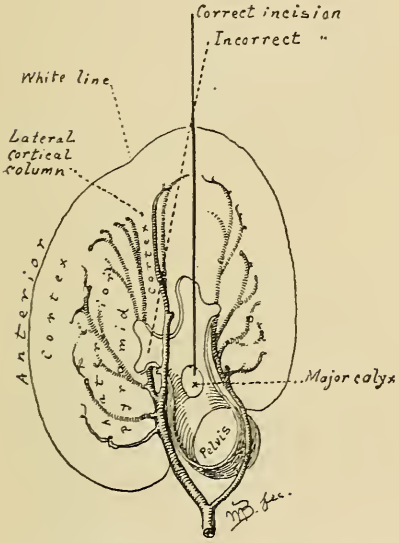


FIG. 309.—Diagram showing location of nephrotomy incision.

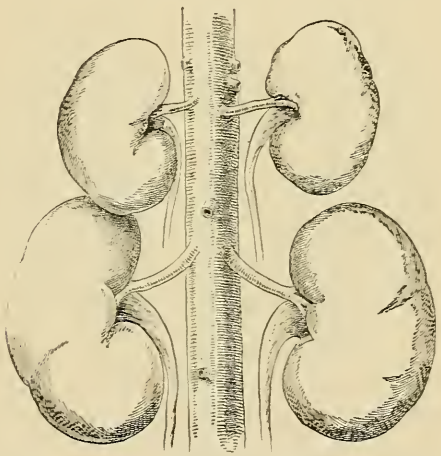


FIG. 310.—Supernumerary kidneys. (Specimen from the Mutter Museum, College of Physicians, Philadelphia.)

influence is exerted through changes in the general circulation. According to the experiments of Oliver, Schäfer, Herring, and others, there is a diuretic principle in the secretion of the posterior lobe of the pituitary gland. "Intravenous injections of saline extract of the infundibular part of the pituitary body produce dilatation of the kidney vessels, accompanied by increased flow of urine; *i.e.*, the extract has a diuretic action. With the first injection this result is accompanied by a rise of blood-pressure and contraction of the systemic arteries." Subsequent injections have the same diuretic action, but usually do not raise the blood-pressure. Very large doses, by causing renal vasoconstriction, may lessen diuresis (Schäfer and Herring).

The probability of the existence of an internal secretion rests on the observation that, while death follows the removal of approximately three-fourths of the renal parenchyma, removal of a slightly smaller amount may be followed by an elimination of water and urea even in excess of the normal, and on the

prolongation of the life of nephrectomized dogs by the injection of blood previously drawn from their renal veins, or by transfusion from normal animals.

Failure of renal activity is denoted by the symptoms commonly spoken of as uræmia, a condition probably caused in part by the failure of the kidneys to remove certain substances from the blood, and partly by failure of these organs to contribute their internal secretion. The condition may be brought about either through renal disease, or as a result of surgical or other trauma inflicted upon the kidneys.

In the event of the destruction of a portion of the secreting structure of the kidney, to a limited extent a compensatory action of the remaining kidney tissue is noted, the compensation being in part an increased function of the normal cells, and in part as hyperplasia, particularly of the cortex, so that after unilateral nephrectomy, or destruction of one kidney by disease, the remaining organ may become nearly double its former size. As would be expected, compensatory hypertrophy is most marked in young, healthy individuals.

ANOMALIES OF THE KIDNEY

The kidneys may vary from normal in number, size, shape, position, attachment, and mobility.

Morris, in an analysis of 11,168 autopsies, found an abnormality of the kidney once in every two hundred and eleven subjects. Exclusive of movable kidney, sixteen cases of multiple ureter, and fifty-three cases of acquired atrophy, the usual anomaly was fused or horseshoe kidney.

There may be more than two kidneys (Fig. 310), or there may be congenital absence of one kidney (Fig. 311). This latter has been noticed sufficiently often to warrant the suggestion that the surgeon, before performing nephrectomy, should make sure of the presence of two kidneys.

Roberts collected twenty-nine cases of solitary kidney, twenty-two of which occurred in males and six in females. The sex was not given in one case. In sixteen cases the left kidney was absent, in thirteen the right.

Ballowitz found that the deficiency was more common on the left than on the right side, and that the single kidney was usually normal in position and shape, but enlarged. A single kidney has sometimes a double vascular supply and two ureters, though showing no other signs of fusion. Morris states that congenital absence of one kidney can be expected once in every two thousand four hundred and fifty-four and one-fifth cases.

The kidney may be congenitally enlarged; this condition is usually associated with atrophy, or possibly with absence, of the other kidney, and is compensatory. A single large kidney seems to be perfectly competent to carry on the functions of both organs, since there are many autopsies recorded showing that the bearers of this malformation have lived to an advanced age and perished of other diseases. Thus, Newman reports seventeen such cases, the patients dying at ages greater than sixty.

Variations in shape may be due to overgrowth or malformation of neighboring organs or structures. Usually these are true growth-perversions, and they may assume a great variety of forms.

The upper or lower extremities of the kidney may be joined by a bridge over the abdominal aorta and inferior vena cava, the organ assuming horse-

shoe shape (Fig. 312); this connection may consist of true kidney structure or may be merely a band of connective tissue. It may closely simulate tumor of the stomach. The kidneys may be fused along their whole inner surface, forming one large oval or rounded organ, with blood-vessels and excretory ducts attached to its centre or possibly to one side. It is stated that there is one horseshoe kidney in every seven hundred and seven examinations. Fusion may present certain bizarre forms, as in a case reported by Gruber, in which one kidney was superimposed upon the other, the long axes of the organs lying at right angles to each other, and both being displaced from their normal position.

FIG. 311.—Single kidney and ureter. The kidney is abnormally large. The bladder shows the entrance of but one ureter. Both vasa deferentia and seminal vesicles are present. (From the Mutter Museum, College of Physicians, Philadelphia.)

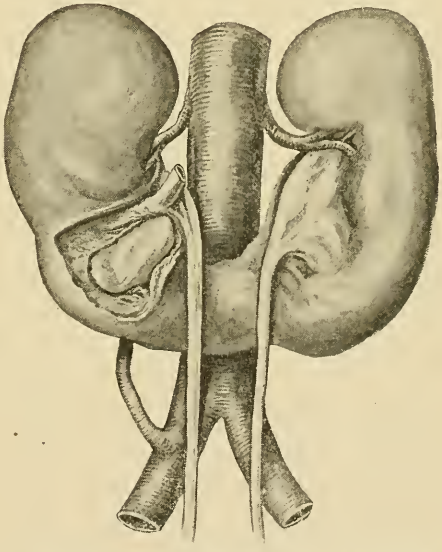


FIG. 312.— Horseshoe kidney. A large calculus lies imbedded in the right side. (No. 70-4-3. Museum of Pathology, University of Pennsylvania.)

The kidney may be found extremely lobulated, a condition normal in the fœtus. When it persists it is due to arrested development. Double ureter and multiple arteries and veins are often noted. Fused kidneys sometimes reach enormous size.

The position of the kidney may vary from the normal in practically any direction except posteriorly. The kidney may lie too high, but this is extremely rare. It is often found over the sacro-iliac articulation, and has been so widely displaced that it has been found in the canal of Nuck. Both kidneys may lie to one side of the vertebral column, either about their normal position or in the pelvis. The kidney may be tilted, rotated, or turned on its long axis. The

hilum may look forward, outward, downward, upward, or backward; this malposition may be associated with fusion.

The anomalies of mobility are of sufficient surgical importance to receive special consideration (see " Movable Kidney "). The other growth-perversions usually excite no symptoms, and are of importance to the surgeon principally because they may cause errors in diagnosis and treatment. Thus, a malformed abnormally placed kidney first discovered during the course of abdominal palpation for the detection of the cause of obscure gastro-intestinal troubles might readily lead to serious error; the removal of a diseased kidney would necessarily be fatal should this happen to be an instance of solitary kidney, partial nephrectomy of the diseased portion of a fused kidney has been successfully performed several times. When the kidney is fixed in a faulty position it usually gives rise to no symptoms. Morgagni, however, states that aortic aneurism was caused by the pressure of horseshoe kidney, and Neufville records the case of a woman, twenty-five years old, previously free from symptoms, who in consequence of the sudden congestion of a horseshoe kidney developed thrombosis of the large veins, which was followed by death.

The only operation practicable for the relief of symptoms due to a kidney congenitally fixed in a faulty position is nephrectomy.

NEPHROPTOSIS

Nephroptosis, or unduly mobile kidney, is exceptionally due to a congenital anomaly in the attachment of the organ, which is completely enveloped in a fold of peritoneum, and is loosely attached to the posterior wall of the abdomen by a mesonephron; hence it lies within the peritoneal cavity. Nor can a recognition of this rare condition, termed floating kidney, be made by means other than operative. The term movable kidney is applied when the peritoneal relations are normal but an excessive mobility is present.

Movable kidney is seven times as frequent in women as in men. The causes of unnatural mobility are such as lessen the intra-abdominal pressure, or mechanically press or pull the kidney from its normal recess. Intra-abdominal pressure is lessened suddenly by parturition, more gradually by emaciation and weakening of the abdominal muscles. The kidney is thrust or dragged from the paravertebral space by strain or traumatism, lateral curvature of the spine, the action of gravity, particularly in cases of pathological enlargement, as in hydronephrosis and calculus, constriction of the lower ribs, as in the case of tight lacing, and the weight of overlying or attached organs, such as the liver or the hollow viscera. In about twenty per cent. of cases both kidneys are abnormally movable. The left kidney alone is rarely affected. The greater frequency with which the right kidney is involved (eighty per cent.) is explained by its relation to the liver and the greater length of its artery.

Three degrees of mobility have been described: *first degree,* when the fingers of the palpating hand can feel the kidney; *second degree,* when the fingers can be brought together above the organ; *third degree,* when the kidney can be depressed into the iliac fossa.

Pathology.—A wide range of motion may cause neither symptoms nor pathological change. It is only when because of such notion there is interference with circulation, the veins being particularly involved, or blocking of drainage

due to ureteral kink or twist, or injurious pull on neighboring organs, that the condition becomes in itself a surgical one.

The vessels and fascia are elongated and thinned, the ureter often partially twisted or kinked, and the renal pelvis shows dilatation from recurring attacks of hydronephrosis. The kidney may be slightly enlarged from passive congestion, or may present distinct evidence of degeneration from back pressure. Perirenal and periureteral adhesions may form from the same cause. The peritoneum over the kidney is lax, the duodenum may be elongated, and the gall-bladder may show the signs of biliary retention secondary to traction on the common duct. In long-continued cases there may be found the phenomena of chronic gastro-intestinal catarrh often associated with general splanchnoptosis.

Symptoms.—Aside from the detection of the tumor by palpation, the cardinal symptom is pain, usually referred to the lumbar region. This may amount to simply a dragging and wearing sensation, made worse by exertion and relieved by rest; or it may be paroxysmal, agonizing in type, exactly resembling the attacks of renal colic caused by blocking of the ureter and sudden tension. These paroxysms recur at irregular periods, are rather sudden in onset, and often follow fatigue or active exertion. Frequently associated with this pain are distinct gastro-intestinal symptoms. If the right kidney is unduly movable, it may partially block the bile-duct and the duodenum, either by direct pressure or by dragging, thus causing hepatic colic, dilatation of the stomach, and symptoms of gastric catarrh. When the left kidney is movable, the same partial blocking or dragging may affect the stomach or the transverse and the descending colon, thus interfering with intestinal digestion.

The renal colic may be referred to the lower part of the abdomen and radiate into the groin and down the thigh. Shortly there develop great tenderness over the kidney both in front and behind, and abdominal distention and tenderness to such an extent as to make renal palpation difficult. This condition may persist for days, but usually subsides in a few hours.

The urine is usually scanty and contains blood. Hypersecretion is an early sign of relief of tension. When fever develops, the diagnosis may be exceedingly difficult.

Neurasthenia is commonly associated with nephroptosis, as are flatulence, constipation, and other signs of gastro-intestinal catarrh, sometimes reflex in origin, usually due to general visceroptosis. By pressure against the vena cava and particularly against the ovarian vein there may be kept up a passive congestion of the pelvic organs, causing menstrual disturbances and predisposing to chronic inflammation (Goelet).

Morris calls attention to the fact that movable kidney and large gall-bladder are each more frequently met with in women than in men, and often occur in the same person. The association of the two states is explained by the custom of wearing corsets. While the downward pressure of the liver induces mobility of the kidney, the mobility of the kidney in turn acts upon the gall-bladder and causes distention by dragging upon the duodenum and the bile-ducts, thus obstructing the passage of the bile. The same mechanism explains the frequency with which gastric dilatation and symptoms of gastro-intestinal catarrah are associated with movable kidney.

If the mobility is sufficiently great to cause kinking of the ureter, hy-

dronephrosis will result. In this event the symptoms will be those of that condition (see p. 663).

Diagnosis.—This is based on the history of a sufficient cause for undue mobility, and of continuous or paroxysmal pain, often with profuse urination following the paroxysms, on associated symptoms of gastro-intestinal derangement, on the finding of a movable tumor by abdominal palpation and by radiograms. If a tumor lying in the hypochondriac, the umbilical, or even the iliac region exhibits the characteristic depression of the hilum, if the pulsation of the renal artery can be recognized, if the growth on manipulation readily recedes into the loin, and if it is of the size and consistence of the kidney, the diagnosis becomes reasonably certain.

Palpation of the kidney may be performed with the patient in a sitting posture, the back being thoroughly supported, or in the dorsal decubitus. In the latter position the thighs should be flexed, head and shoulders elevated, and the trunk slightly inclined towards the side to be examined by a thin pillow placed under the opposite loin. The examiner places the fingers of one hand just below the twelfth rib, those of the other below the costal margin in front over the position of the lower pole of the kidney, and by gradually increasing bimanual pressure sinks the anterior examining fingers so deeply that the kidney may be felt in its inspiratory descent. In the majority of muscular, well-nourished patients with normally movable kidneys these organs cannot be felt. In weak and emaciated women the kidney, even though but normally mobile, can usually be felt on the right side. When the kidney descends so far during inspiration that its expiratory ascent can be prevented by firmly pressing against it with the examining fingers, the mobility is abnormal, and this is still more true when the entire organ can be pressed and held downward by thrusting the fingers upward and backward after a full inspiration. The gravity of renal mobility is, however, gauged by the renal changes and the symptoms produced by it, and these are not necessarily proportionate to the range of motion.

Malignant colonic and omental growths, solid tumors of the ovaries, growths of the abdominal wall, and enlargement of the spleen can usually be readily excluded, partly from the radical difference in the history, symptoms, and clinical course, mainly by careful palpation, followed by colonic air-distention and palpation and auscultatory percussion. The kidney lies behind the colon.

Distention of the gall-bladder so closely simulates movable kidney that differentiation is extremely difficult. Both may be characterized by gastro-intestinal catarrh, jaundice, colicky attacks, albuminuria or biliuria, and the presence of a tumor in the right upper abdominal quadrant. In distinguishing between these two affections the history is of cardinal importance. Enlarged gall-bladder is particularly characterized by extreme ease of palpation, constant or increasing size, the slight influence of posture upon its position, free respiratory movement, its apparent continuousness with the liver substance both on palpation and percussion, and its limited range of mobility under manual pressure. Neither can it be made markedly to recede to the loin. Colicky attacks give no radiation downward and are not attended or followed by hæmaturia. Movable kidney exhibits limited respiratory motion, but a free range incident to palpation or body position; it can be separated from the liver, is at times difficult to feel, varies greatly in size, can be made distinctly

more accessible by upward lumbar pressure, and recedes to the loin. Colicky attacks are associated with pain radiating downward, and are attended and followed by hæmaturia.

Moreover, the pressure upon a tender kidney produces a peculiar sickening much like that incident to testicular trauma. When the surgeon is in doubt, the condition is usually movable kidney.

The two conditions may coexist. In this case careful palpation will enable the surgeon to separate one tumor from the other.

The distinction between movable kidney and calculus is readily made when each has developed typically; when the mobility of the kidney, though sufficient to cause blocking of the ureters, is so slight that it cannot be detected by palpation, the differential diagnosis is made possible by the skiagraph.

Omental or mesenteric infiltrations or pyloric carcinoma cause neither the colicky paroxysms nor the urinary phenomena of movable kidney.

In doubtful cases conclusive proof is often furnished by radiograms made with the patient in both the erect and recumbent positions, after the injection of collargol, or with radiographic catheters in the ureters.

Prognosis.—The ultimate prognosis so far as the kidney itself is concerned is bad in all cases accompanied by distinct renal symptoms and pathological conditions of the urine. When the pain is slight, or, if severe and paroxysmal, when it recurs at long intervals, lasts but a short time and is relieved promptly by position and rest, and when symptoms are not steadily increasing in severity, the outlook is favorable, and the patient can probably be kept comfortable by the wearing of a proper appliance. Severe, long-lasting pain, of frequent occurrence, necessarily implies ultimate disorganization of the secreting substance of the kidney, since this pain is due to tension or twisting of the pedicle, either of these conditions causing profound alterations in nutrition.

Pronounced mobility may be unattended by renal symptoms or alterations in the urine, and under such circumstaces does no harm. An amount of motion which cannot be detected by the most careful palpation may be sufficient to cause pronounced symptoms. Sooner or later a movable and degenerating kidney profoundly alters general nutrition, often producing a condition of melancholia or neurasthenia. The gastro-intestinal symptoms when once well developed are commonly progressive unless the mechanical cause is removed.

Debove has shown that chronic hydronephrosis of one side may cause interstitial nephritis of the other.

Treatment.—This is either palliative or radical.

Palliative Treatment.—The condition can be palliated, often cured, by a rest cure of five weeks in the dorsal decubitus, with particular attention paid to abdominal massage, correction of slight lateral spinal curvature, exercises calculated to develop the abdominal muscles, and the application of a support, so planned that the abdominal parietes are evenly supported and enteroptosis is prevented. The straight-front corsets are well adapted to this purpose. The corset must be accurately fitted by measurements taken with the patient in dorsal decubitus with elevated hips, and should always be laced on with the patient in this position (Fig. 313). Its greatest pressure should be exerted upon the lower abdominal segment, the front being carried down as far as possible. Moderate support should be afforded at the waist-line, and great care

should be taken to see that there is no pressure above this line. In place of the corset a pad held in place by a spring truss serves well (Fig. 314). The pad fills the space above the pubis and within the flare of the pelvis to the level of the anterior superior spines of the ilium, and by its spring presses the abdominal content upward and backward. In some cases of nephroptosis and

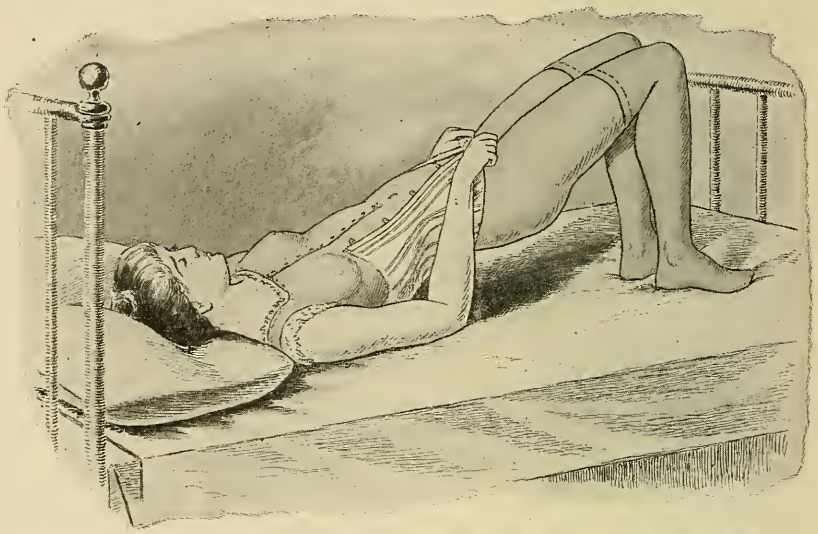


Fig. 313.—Proper method of applying corset for movable kidney. (Dr. Ernest A. Gallant.)

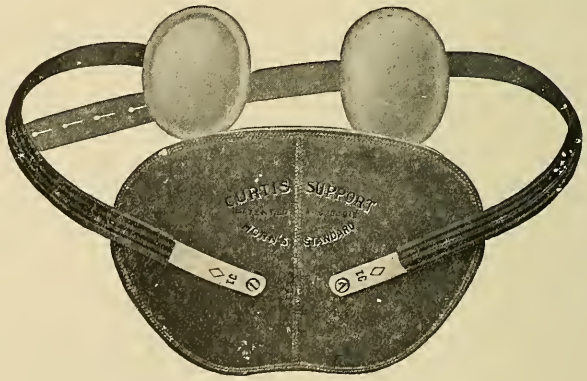


Fig. 314.—Lane-Curtis abdominal support

general visceroptosis a dressing of adhesive plaster is more efficient than the corset or truss (Fig. 315).

Patients must be cautioned against violent exertion or straining of any kind. The bowels must be kept soluble, since the muscular effort required to evacuate hardened fæces tends to displace the kidney. Digestive disturbances should be corrected by diet and proper medication, and due attention should be given to general hygiene. The acquisition of abundance of fat is much to

be desired. When in spite of this treatment the symptoms of obstruction persist, nephrorrhaphy is indicated.

When sudden violent pain shows that the pelvis or ureter is blocked, an attempt should at once be made to place the kidney in its proper position. In

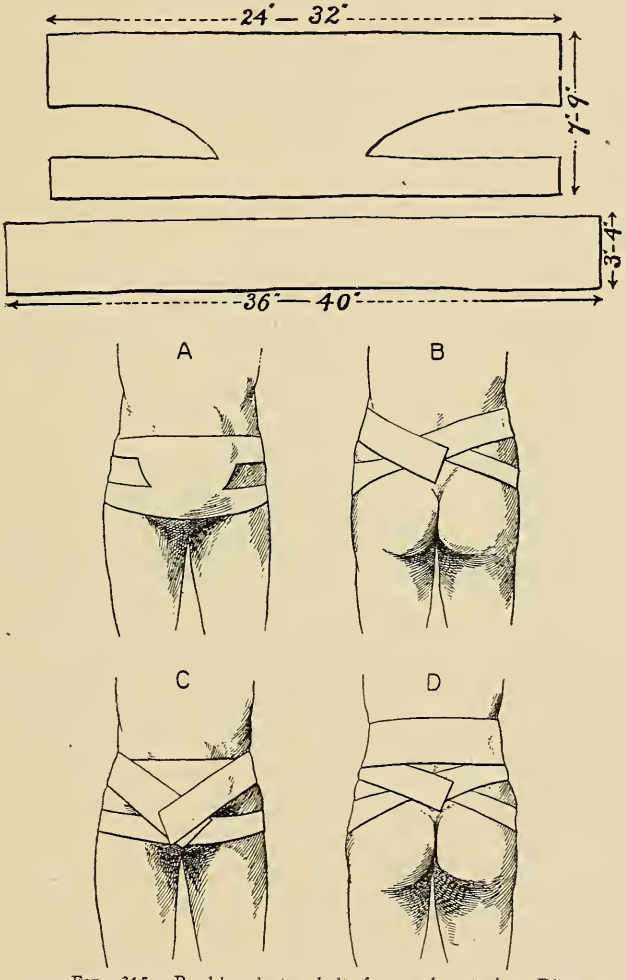


FIG. 315.—Rugh's plaster belt for nephroptosis. Diagram at top shows variable dimensions in inches of the two strips of zinc oxide plaster used in the dressing. A and B, anterior and posterior views respectively after applications of first belt; C and D, anterior and posterior appearance after the application of the second belt.

the intervals of paroxysmal pain this is usually accomplished without difficulty. Patients suffering from movable kidney are apt to be thin, with lax abdominal walls: hence the kidney can be distinctly palpated, and pressure can be so exerted that it will slip readily into its normal place.

During the attacks of pain, especially when these are complicated by symptoms of local peritonitis, this reposition may be difficult. Nevertheless, it should

always be attempted, ether being given if necessary. No force should be used, since the surgeon is to a certain extent acting blindly. The kidney should be outlined, mobilized, and restored to its normal position if possible. Severe pain is quieted by a hot bath and the use of hypodermics of morphine, repeated as often as may be necessary. Hot compresses should be applied over the abdominal surface when tympany develops.

Operative Treatment.—This has for its end fastening the kidney in its normal position by sutures and adhesions, the operation being known as nephrorrhaphy or nephropexy. It is indicated when in association with an abnormal degree of mobility the symptoms are distinctly renal, and do not yield to rest, hygiene, and a proper abdominal support.

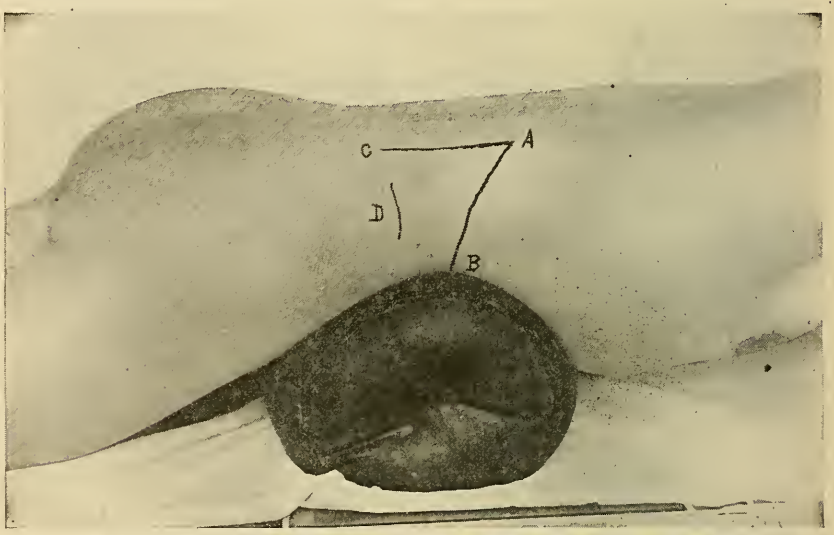


FIG. 316.—Edebohls's position; air pillow beneath abdomen—chest raised from table by pads beneath shoulders. Incision (AB) from costovertebral angle (at the junction of the sacrospinalis muscle with the last rib) forward just below the rib; it may be extended to the rectus muscle if needful (the patient then being turned on the side). Vertical incision (AC) to the outer side of the sacrospinalis muscle and parallel with it—used when the operative procedure is simple and a long waist gives ample room. D, iliac crest.

When both kidneys are to be operated upon the patient is placed in the ventral decubitus across an air-cushion (Fig. 316). When but one kidney is to be secured, it is more convenient to have the patient lying on the sound side (Fig. 317), that thigh and leg being flexed, while the thigh and leg of the affected side extend nearly straight downward. The arm of the sound side should be drawn forward of the chest to prevent pressure on the nerves, and the upper shoulder should drop slightly forward. An air-cushion or some similar device should be placed in the iliocostal space.

The instruments required are a strong scalpel of medium size, dissecting forceps, toothed forceps, half a dozen hæmostatic forceps, two broad right-angled retractors, two large curved needles, and a grooved director. The usual incision for nephropexy in long-waisted individuals starts at the costovertebral angle at the juncture of the twelfth rib and the outer edge of the sacrospinalis

(erector spinæ) muscle, and passes downward along the outer margin of this muscular mass to the crest of the ilium. The strong dorsolumbar fascia (Fig. 318) is cut close to the side of the sacrospinalis, giving access to the kidney space without dividing muscular tissue. The retractors are passed down to the perinephric fat, and the wound is spread open as widely as possible. While an assistant presses the kidney upward and backward into its normal position, the fatty capsule is seized in rat-tooth forceps and opened with a knife, after which the dorsal surface of the kidney is freely exposed. The sutures of chromicized No. 2 catgut are inserted in the postero-convex border, one near the upper pole, the other well below the middle, thus preventing inward or forward rotation. Each is passed from above downward for half an inch beneath the capsule, then from below upward the needle entering a quarter of an inch from its previous point of exit for half an inch, coming out near the

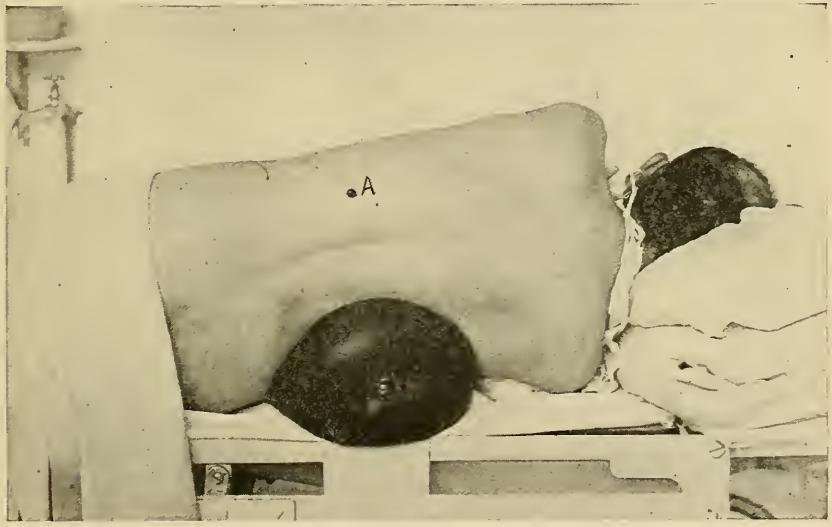


FIG. 317.—Lateroventral lithotomy position (ventral rotation a little more marked than indicated in the picture). A, Costovertebral angle, about four fingers' breadth from the line of the vertebral spines. Line of incision parallel with the last rib and half a finger's breadth below it, running forward to the rectus or even beyond its outer border, as required. Border of last rib and crest of the ilium indicated.

point of original entrance (Fig. 319). Brödel has demonstrated that thus placed the sutures stand three times as much traction as by the older methods, and are hence much less likely to tear out from the effort of coughing or vomiting. These sutures are carried through the fatty capsule, transversalis fascia, and deep muscles, and are tied down after the incision through the muscles and fascia is firmly closed by a sufficient number of buried catgut sutures. No drainage is used.

After operation the patient should lie in the dorsal decubitus for at least five weeks, should wear a supporting bandage or straight-front corset for six months, and should avoid violent strain or muscular effort for a much longer period. The mortality of the various forms of nephrorrhaphy is less than two per cent. Mechanical cure is the rule, and in the majority of properly selected cases complete relief from symptoms may be expected.

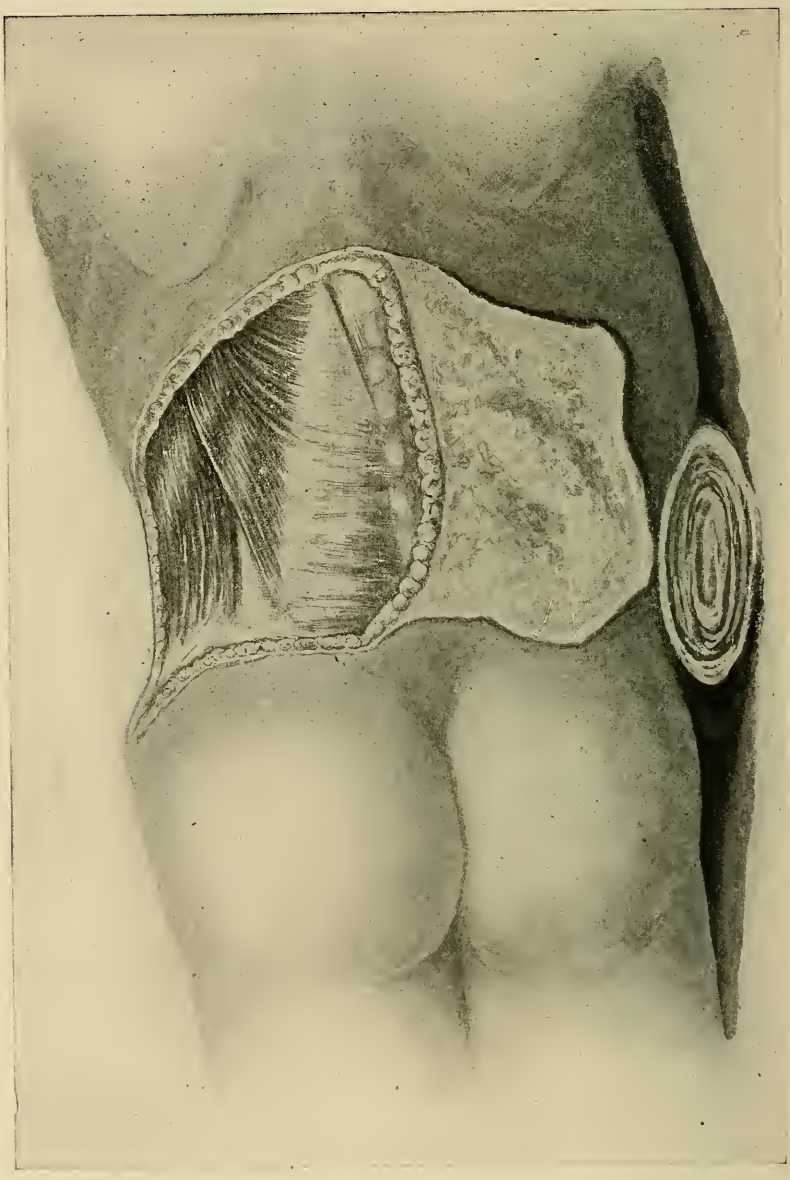


FIG. 318.—Dissection of iliocostal space, exposing the superficial muscles. Petit's triangle is shown between the external oblique in front and the latissimus dorsi behind, its floor being formed by the internal oblique. Incision of the strong dorsolumbar fascia from which the latissimus takes its origin, along the outer edge of the sacrospinalis (erector spinæ), which can be seen lying beneath the fascia, gives entrance to the kidney space without division of muscular tissue.

Many surgeons prefer to incise the capsule of the kidney a little back of the midline, strip it up for a short distance to each side, and insert two or three mattress sutures into each leaf of the capsule, the ends of the sutures being brought out through the muscles on each side of the incision, and tied down after the muscle wound has been closed.

When the operation of nephrorrhaphy has been carefully performed twice and has been unsuccessful, or when it is impossible to place the kidney in the proper position, and symptoms are severe and progressive, nephrectomy is a justifiable operation.

Newman gives the mortality of this operation for movable kidney as thirty per cent. The operation is not to be considered unless there is absolute certainty as to the existence of a sound kidney which is able to carry on the work of elimination. For the purpose of total removal the kidney may be reached from

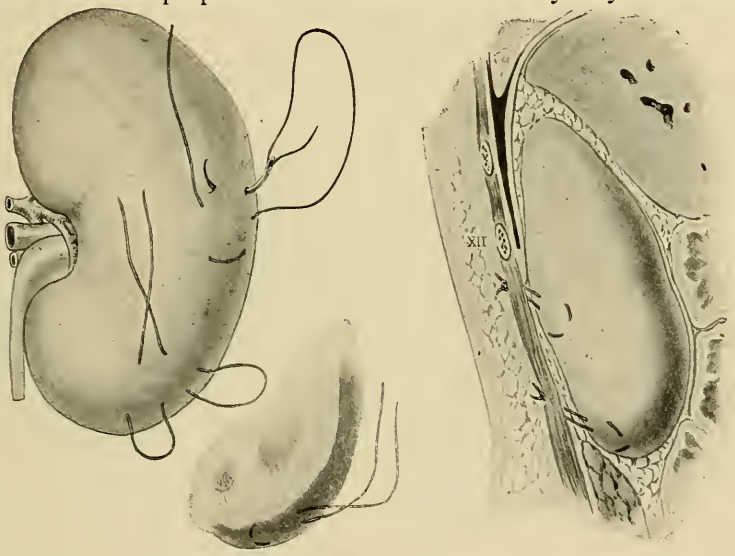


FIG. 319.—Sustaining sutures for fixing the kidney. (Brödel.)

in front through the linea alba or the linea semilunaris, or from the lumbar region, as in the operation of nephrorrhaphy. When ureteral catheterization has failed to demonstrate the condition of the other kidney, or even its presence, the abdominal operation is to be preferred.

The treatment just given for movable kidney is applicable to floating kidney; in operating, however, the peritoneal cavity must be opened unless the two layers of the mesonephron are widely separated.

INJURIES OF THE KIDNEYS

In accordance with surgical classification, injuries of the kidney may be considered under the general headings contusions and wounds, the former exhibiting no external wound leading down to this organ.

CONTUSION OF THE KIDNEY.—Direct violence is instanced by kicks, blows, or crushing pressure, as from the wheels of a cart, applied to the lumbar region. Except in cases complicated by fractured bones and injury to other important

viscera, the vulnerating body is usually small, or at least narrow, since there is a comparatively small unprotected space through which it can act directly on the kidney, particularly when it is applied suddenly and unexpected, thus surprising the parietes when they are relaxed, and when the ilio-costal space is broadest. Direct violence usually involves the right kidneys of men.

Indirect violence is instanced by contortions or flexions of the trunk, or by violent jarring from a fall.

The injury may vary in severity from moderate contusion to laceration, or to complete disintegration.

The first degree of contusion (Tuffier) is characterized by subcapsular ecchymoses. When the violence has been more marked (second degree), intrarenal blood extravasations are found, most marked and constant at the base of the pyramids. In the third degree the capsule is ruptured; there is extrarenal hemorrhage, and deep, multiple, stellate fissures of the kidney-substance are produced, most pronounced about the hilum, sometimes completely dividing the kidney. Finally, the organ may be reduced to a pulpy detritus; exceptionally a large branch of the renal artery may be ruptured. Bleeding within the kidney is rarely profuse. Extrarenal hemorrhage may, however, be fatal.

Severe contusion of the kidney is often complicated by rupture of the liver, the spleen, the intestines, the lungs; the peritoneum lying in front of the kidney is likely to be torn, particularly in children, in whom the fatty envelope of the kidney is wanting. Injuries to the kidneys are the most frequent visceral lesions of abdominal contusions; as a rule, other viscera are not involved. (Mackin).

Symptoms.—Symptoms of contusion of the kidney are shock, pain, hæmaturia, diminution in the quantity of urine passed, and the formation of a tumor.

Shock is usually pronounced, particularly when the kidney is lacerated or completely ruptured. However, it may be slight even in case of rupture, and may be entirely wanting in slight contusion characterized by superficial or parenchymatous ecchymoses.

Pain, usually the first symptom, varies in intensity from a sickening, weakening ache to an unbearable anguish comparable to that characteristic of nephritic colic. It is felt in the lumbar region, but usually radiates down the ureters, and is often accompanied by retraction of the testis. It may be transitory, or may last for several days. It is often accompanied by nausea, vomiting, and tympany. When it persists it is liable to be paroxysmal, and is then probably due to temporary ureteral obstruction and kidney tension, caused by the passage of clots through the ureter.

Hæmaturia may follow an injury to the abdominal wall, and does not necessarily indicate that the substance of the kidney has been bruised. When it is easily excited it is usually a sign of a masked lesion of the kidney, such as encysted calculus, which may have been dislodged, or a preëxisting thrombus, or tumor, or renal tuberculosis.

When the kidney is contused hæmaturia is practically constant, and is often profuse. Blood may appear, either immediately after the injury or not for several hours; it may persist for several days, or may be abundant for a day or two and then suddenly cease, because the ureter is blocked by a clot. In this case there will probably be renal colic; when the clot is passed pain will cease, and there will be recurrence of blood in the urine. The quantity of blood passed

is, as a rule, proportionate to the severity of the lesion. If, however, the ureter is torn across, or if it becomes at once blocked by a large clot, the urine may remain perfectly clear, even though the kidney be pulpified.

The blood usually disappears within a week. Sometimes it persists for several weeks, and exceptionally, instead of growing less, it steadily augments in quantity until the patient perishes of anæmia. The clot, in place of passing through the ureter, may permanently occlude it, causing hydronephrosis or atrophy of the kidney. Butler reports a case of left ureteral obstruction from clots incident to renal trauma persisting for fourteen days, with complete suppression of urine. The nontraumatized kidney was found at autopsy to be atrophic and cystic. Frequent and painful urination is not an uncommon symptom when blood is passing through the ureter in the shape of clots which act as foreign bodies in the bladder; often there is retention of urine.

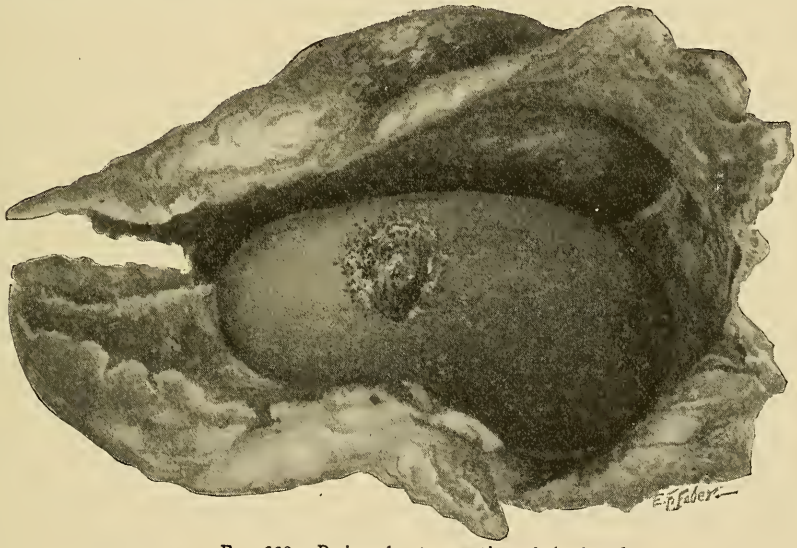


FIG. 320.—Perirenal extravasation of the blood.

Alteration in the quantity of urine secreted constitutes an important symptom of kidney contusion. Urine may be totally suppressed immediately after the injury, or this suppression may not develop until some hours later. It is often followed by compensatory polyuria.

The formation of a tumor is primarily due to hemorrhage; even though this be subcapsular the enlargement may be palpable. When the capsule is ruptured and there is free bleeding into the perinephric tissues, there is quickly (hours) formed an extensive and increasing area of dulness and swelling in the lumbar and possibly in the iliac region. The hemorrhage may be so rapid and profuse that marked constitutional symptoms develop—*i.e.*, feebleness and rapidity of the pulse, pallor, coldness of the extremities, and collapse. Tumor of the loin was present in one hundred and eleven of Watson's four hundred and eighty-six cases. It was usually due to perinephric abscess, hydronephrosis, or pyonephrosis; thirty-nine cases were caused by perirenal bleeding and four by hæmatonephrosis.

Rayer states that in intrarenal bleeding the swelling is sharply circumscribed, forms later and more slowly than in perirenal extravasation, and is rounded and movable. Perirenal extravasation is diffuse (Fig. 320). Satisfactory palpation is in these cases often impossible, because of the exquisite sensitiveness of the kidney and the region about it. When the hemorrhage is confined to the pelvis of the kidney and the ureter it seldom forms an appreciable tumor.

A perirenal blood effusion is sometimes evacuated with the urine, this occurring, according to Tuffier and Levi, towards the end of the second week following the injury and being characterized by the subsidence of the tumor and the reappearance of blood in the urine, which may have been clear for several days.

Rupture may take place into the peritoneal cavity, a complication which is generally fatal. Intraperitoneal bleeding is characterized by the rapid development of tympanites and signs of peritonitis, together with symptoms of internal hemorrhage.

Diagnosis.—The diagnosis of contusion of the kidney is based on—(1) The form of traumatism: thus, the sharp corner of a table striking the side between the pelvis and the costal border, a kick or a blow delivered from before backward below the ribs and over the region of the kidneys, a crushing force fracturing the lower ribs, or extreme flexion or extension of the body, would be sufficient cause for kidney-rupture. (2) The appearance of blood in the urine, in the absence of bladder-lesion. The rare cases in which such bleeding follows simple traumatism of the back may be disregarded. If the bleeding is profuse and exhibits worm-like clots, it offers the characteristics of traumatic renal hemorrhage; the renal origin of the hemorrhage may also be recognized by cystoscopy. (3) Marked diminution in the quantity of urine secreted, or complete suppression of the secretion. This symptom may follow any severe traumatism to the abdominal contents. It may be of value when associated with hemorrhage. (4) The rapid formation of a lumbar swelling associated with extreme tenderness. (5) Intense pain radiating in the direction of the ureter and accompanied by retraction of the testis. (6) Subcutaneous ecchymoses developing several days after the injury. These may appear in the loin, or may be found in the inguinal region. Dumesnil has particularly insisted upon the importance of this symptom, and states that it is indicative of serious injury.

The group of symptoms is diagnostic. It has been shown, however, that they are often not associated; thus, hæmaturia, the most characteristic symptom, may be absent; but if the kidney-lesion is extensive a hæmatoma is certain to form. When the peritoneum is ruptured, and extensive bleeding takes place into the general peritoneal cavity, the only symptoms pointing to injury of the kidney will be hæmaturia and possibly characteristic pain; shock and peritonitis quickly mask the other symptoms indicative of kidney-lesion. Abdominal symptoms are occasionally noted, however, in the absence of intraperitoneal rupture; they occurred in eighteen of Watson's cases. They become marked immediately or very soon after the accident, are of relatively short duration, and are not progressively severe. The one sure sign of intraperitoneal rupture of the kidney is free fluid in the peritoneal cavity, as indicated by non-circumscribed, generally bilateral, movable dulness. In cases uncomplicated by peritoneal rupture the area of dulness is unilateral, and is more or less cir-

cumscribed, extending three or four fingers' breadth below the costal arch and as far forward as the mid-clavicular line. Upon its progressive rapid increase in size often depends the advisability of operative interference. Progressive, but slow, increase in size of this area of dulness occurs with the development of perinephric abscess (sixteen of Watson's cases), and with hydronephrosis (eight of Watson's cases).

Ruptured bladder is characterized by pain in the hypogastrium with vesical tenesmus and the passage of a small amount of bloody urine, or inability to pass any urine and the finding of an empty bladder (see p. 481).

Prognosis.—Most cases of contusions of the kidney of the first degree, characterized by subcapsular ecchymosis, heal spontaneously apparently without sequelæ, and probably this is true of the cases exhibiting disseminated extravasations into the substance of the kidney. When the organ is extensively ruptured the prognosis is grave. According to Morris, the two chief conditions upon which recovery depends are the escape of the peritoneum and of the large branches of the renal artery and vein; if a large branch of the renal artery be torn, and death does not follow from bleeding, the gradually increasing hemorrhage is likely to lead by pressure to sloughing of the peritoneum, even though that membrane may have escaped the original injury. Recovery may follow extensive laceration or even complete pulpification of the kidney. This, however, is rare. Duplay and Reclus state that in simple lacerations the mortality is forty-three per cent.; in laceration complicated by rupture of other organs or fractures of the neighboring bones the mortality is eighty-seven per cent.

Complications.—Complications which are immediately threatening to life after rupture of the kidney are shock, hemorrhage, and anuria. Later the chief danger is from sepsis; the conditions are so favorable for its development that it is one of the most frequent causes of death in patients who survive the immediate effects of the injury. If the kidney capsule has been ruptured suppuration extends into the perinephric tissues. Chills, fever, increasing pain and tenderness in the lumbar region, and marked diminution in the quantity of urine secreted, should suggest the probability of infection and should lead to lumbar incision.

Cystitis is a complication which often follows uncleanly catheterization and may even lead to infection of the sound kidney. Hydronephrosis may develop as a consequence of the blocking of the ureter by a clot; this, in case of infection, becomes converted into pyonephrosis. Traumatic peritonitis from the escape of blood and urine into the peritoneal cavity, and thrombosis of the renal vessels, are sequelæ that have been frequently fatal. The kidney may be displaced from its normal position, and thereafter may remain preternaturally movable. As a remote sequel of traumatism various forms of Bright's disease may develop. Exceptionally the blood-clots form nuclei for renal stones. Ebstein holds that contusion is a predisposing factor in the development of renal tumors.

Treatment.—Shock is treated in accordance with general surgical principles. When there is reason to believe that the kidney is bruised, the patient is put to bed, is kept absolutely quiet, and is given hypodermic injections of morphine for the relief of pain if this is severe. When the hemorrhage is profuse, blood-serum is given hypodermically, an ice-bag is applied to the lumbar region, and

the side is strapped with long strips of adhesive plaster, applied as for fractured ribs. In addition to the straps a broad roller bandage is applied; this secures a compress of gauze or cotton over the kidney. It is unwise to give either medicine or food by the mouth for the first few hours, since the patient is likely to vomit, and this may cause recurrence of bleeding. The straining and retching which occur even when the stomach is empty are best relieved by sufficient doses of morphine. Thirst may be appeased by rectal injections of half-normal salt solution, a pint at a time, at blood heat.

A fairly well-nourished man can subsist for many days without nourishment of any kind, and it is wise to withhold even liquid food until the stomach is retentive. For three weeks at least after suspected injuries of the kidney the diet should be moderate in quantity and simple in quality, and the intestinal evacuations should be so regulated as to be accomplished without straining. Coughing, sneezing, forced efforts at micturition, or defecation, sitting up, any act which may suddenly change the conditions of intra-abdominal pressure, should be avoided. As soon as the stomach becomes retentive, salol or hexamethylenamine should be given by the mouth for the purpose of rendering the urine slightly antiseptic, and the patient should drink an alkaline water freely, since the lower the specific gravity of the urine the less the tendency towards the formation of clots.

Should retention of urine develop because of clots blocking the urethra, an effort should be made to relieve this condition by a hot bath. This failing, the suction catheter or the litholapaxy tube and evacuator may be used. These instruments must be employed with minute attention to aseptic precautions. Should the suction catheter or the evacuating-tube not succeed in evacuating the bladder-contents, or should there be frequent recurrence of retention from clots, requiring repeated catheterizations, cystotomy is indicated, followed by the insertion of a large tube, and by frequent irrigations of the bladder.

Should hæmaturia persist and constitutional symptoms show that loss of blood is producing dangerous anæmia, surgical intervention is imperative. This should take the form of an exploratory lumbar incision. The kidney can thus be thoroughly exposed, the extent of injury determined, and the bleeding stopped by ligature of the torn vessel, ligation and excision of a portion of the kidney, firm packing, or nephrectomy. This last operation is indicated when the kidney exhibits multiple and extensive lacerations. Lumbar incision is also indicated in cases exhibiting no blood in the urine, but rapidly developing a lumbar tumor associated with symptoms of internal bleeding, and in those showing the constitutional and local symptoms of infection.

Owing to the depth and inaccessibility of the wounded vessels, it may be impossible to tie them, or, even if they were tied, the blood-supply of the kidney might be thereby so curtailed that necrosis would be certain to result. Under these circumstances nephrectomy is indicated. Children are less able than adults to resist internal hemorrhage, but are apparently more likely to recover from nephrectomy. Therefore nephrectomy in them may be performed with less absolute indications than with adults. When a lesion of the peritoneum is suspected, a transperitoneal operation should be performed.

Of two hundred and seventy-three cases treated expectantly, twenty-seven per cent. died; of one hundred and fifteen cases treated by nephrectomy,

twenty-five per cent. died; of ninety-eight cases treated by operation other than nephrectomy, seven per cent. died. Hemorrhage and sepsis caused the greatest number of deaths (Watson).

Wounds of the Kidney.—Wounds of the kidney, much rarer than contusion or rupture, are conveniently classed in accordance with their causes as gunshot, punctured, and incised wounds.

Gunshot Wounds.—A bullet which wounds the kidney is very likely to injure other viscera. Of seventy-eight cases of gunshot wound of the kidney reported by Otis, other viscera were wounded in thirty-three. Balls usually pass through the kidney, sometimes leaving in its substance portions of clothing; exceptionally they are buried in the secreting portion of the organ: thus, Simon found a bullet encysted in the kidney parenchyma.

The bullet may wound simply the secreting substance of the kidney, may pass through the pelvis, or may tear the great vessels. When the wound involves only the kidney-substance there is moderate bleeding with no extravasation of urine, and, provided other organs are spared, healing takes place with extraordinary rapidity. The modern army rifle, either at close or at long range, may practically pulpify the entire organ.

When the pelvis is opened there will be urinary extravasation. This, however, need not lead to infection. The bleeding is usually more profuse than when only the secreting substance of the kidney is involved, and, unless the ureter is torn completely across, there will be hæmaturia. When the large vessels are cut, hemorrhage is so severe as to threaten life. The blood may be poured out into the perinephric tissues, into the peritoneal cavity, and into the bladder through the ureter.

Punctured wounds, such as those made with a needle in kidney exploration, are entirely safe, unless infection is carried with the vulnerating instrument. When made with a comparatively blunt instrument, as the prong of a hay-fork, there are contusion and laceration in addition to the puncture, and the consequences are the same as those incident to gunshot wound.

Incised wounds are rare, since the position of the kidney protects it. Incised wounds are much more liable to be entirely extraperitoneal than are those inflicted by fire-arms. The wound of entrance is often in the lumbar region; stabs and cuts inflicted from in front rarely extend backward as far as the kidney. As in the case of gunshot wounds, these injuries may involve the secreting substance, may open the pelvis, may divide the large vessels, or may sever the ureter.

A few cases have been reported in which, after extensive wound of the lumbar region, the kidney has protruded.

Symptoms.—The chief symptom of wound of the kidney is hæmaturia. If the pelvis has been opened there will also be escape of urine through the wound. Pain may be severe, assuming the type of kidney colic. Oliguria is constant; exceptionally there is complete suppression of urine.

Diagnosis.—The diagnosis is based on—1, the nature of the vulnerating body, its direction, and the depth to which it has penetrated; 2, blood in the urine; 3, escape of urine from the wound; 4, examination of the kidney through the wound or through a lumbar or an abdominal incision.

When the entrance-wound of a bullet is over the kidney, and the direction

of its track is towards this organ, this constitutes a reasonable ground for suspecting injury to the kidney, since the course of a bullet in the body is usually straight; hæmaturia would then make the diagnosis reasonably certain. The kidney may, however, be injured by a ball which enters the body at a considerable distance from the parietes overlying it; thus, Otis mentions a case in which the bullet entered just below the clavicle. Hæmaturia and escape of urine through the wound are diagnostic of wound of the pelvis or of the ureter rather than of the kidney.

Palpation of the kidney is sometimes possible through an incised wound, such as would be inflicted by a stab with a broad-bladed dirk.

Prognosis.—Incised wounds of the kidney heal readily; even though the pelvis is opened and there is escape of urine, this does not materially interfere with recovery, provided the ureteral lumen is not encroached on. These injuries are dangerous chiefly from primary hemorrhage, which is likely to be profuse, and from the wounding of other viscera. Of thirty-one incised wounds collected by Duplay and Reclus, eight died. In six of these the kidney-wound was complicated by involvement of other viscera.

In the absence of profound shock and severe hemorrhage, the prognosis of kidney-wound is favorable, even though the organ is very extensively injured, since in the great majority of cases the wound is unilateral and occurs in persons possessed of a sound kidney capable of performing the work of both. The prognosis of wounds, opening the peritoneum overlying the kidney, is much more serious than is that of extraperitoneal wounds.

Gunshot wounds commonly involve other viscera. Thus, of thirty-eight cases collected by Duplay and Reclus, eleven of the sixteen deaths were attributable to multiplicity of the lesions. The complications and sequelæ of wounds of the kidney are those described when considering contusions; the danger of infection is greater in wounds than in contusions, since it may reach the kidney either from the ureter or from the parietal opening.

Treatment.—The general treatment of wound of the kidney is that already described as appropriate to contusion. The wound itself should be cleansed, and should be drained, even though there be no escape of urine, since the vulnerating body is never sterile.

When a bullet entering the body from in front has passed towards the kidney, and there follow hæmaturia and symptoms of internal hemorrhage, cœliotomy should be performed at once, since this enables the operator not only to deal with the kidney, but to recognize and close wounds of the abdominal viscera. When the wound is in the lumbar region and there is doubt as to whether or not the peritoneal cavity has been entered, the lumbar incision is preferable.

The indication for immediate operation, as far as the kidney is concerned, is hemorrhage. The kidney having been exposed, either by an incision through the linea alba, along the outer border of the rectus muscle, or in the lumbar region, according to the position of the wound, the bleeding point is sought for and secured, by ligature or suture, if this is possible, or by packing in case the ligature cannot be applied and there seems a fair prospect of saving the kidney, or by nephrectomy.

If the wound involves only the secreting portion of the kidney, it should

be cleaned, and packed. If the renal artery or vein is torn, or if the kidney is so extensively disorganized that repair is impossible, nephrectomy is indicated. If the pelvis is opened, it should be closed by suture, if possible, or provision made for lumbar drainage. If the ureter is torn across its upper portion, lumbar drainage is usually indicated, since from loss of blood the patient is not prepared to stand a prolonged plastic operation. Should recovery take place, implantation of the ureter into the pelvis may be effected subsequently. Blood or extravasated urine found in the peritoneal cavity should of course be removed by gentle sponging, the kidney being then shut off from this cavity by suture of the peritoneum. Extensive accumulation of blood in the perinephric and postperitoneal tissues should be removed, since absorption is slow and huge abscesses will develop if infection occurs.

NEPHRECTOMY

The operation usually referred to by the term nephrectomy is the extracapsular removal of the kidney through a loin incision. Other methods of removing the kidney are the subcapsular lumbar operation, lumbar morcellement, and transperitoneal nephrectomy. Subtotal nephrectomy is rarely performed.

FIG. 321.—Lateral view, showing extent of transverse incision when free exposure is needful. A, Costovertebral angle; B, end of 12th rib.

LUMBAR EXTRACAPSULAR NEPHRECTOMY.—The incision should be four inches long, beginning about two and a half inches from the spines of the vertebræ, and running parallel to the twelfth rib, and a full half inch below it, in order to avoid wounding the pleura. This incision may be prolonged when needful almost to the midline of the abdomen (see Fig. 321), the sheath of the rectus being opened and that muscle displaced. The fibres of the external and internal oblique muscles must be divided; the transversalis may be split in the direction of its fibres. By careful suture of the fascia of the individual layers a strong abdominal wall may be left. When the upper pole is closely adherent mobilization of the twelfth, or twelfth and eleventh ribs (see Figs. 322, 323, and 324) is sometimes needful. When the kidney has been exposed, as in nephrorrhaphy, and freed from any adhesion to its fatty capsule, and blood-clots have been removed, it should be delivered by passing the forefinger about one of the poles (the upper is usually the one first delivered), and drawing it outward and backward till it rests on the parietal wound surface; the lower pole is turned out in a similar manner. Its pedicle should be dissected free of its fibro-fatty investment till the blood-vessels and ureter can be separately clamped. The former are seized in two pairs of forceps not less than a quarter of an inch from each other, are sectioned distal to the peripheral forceps, and

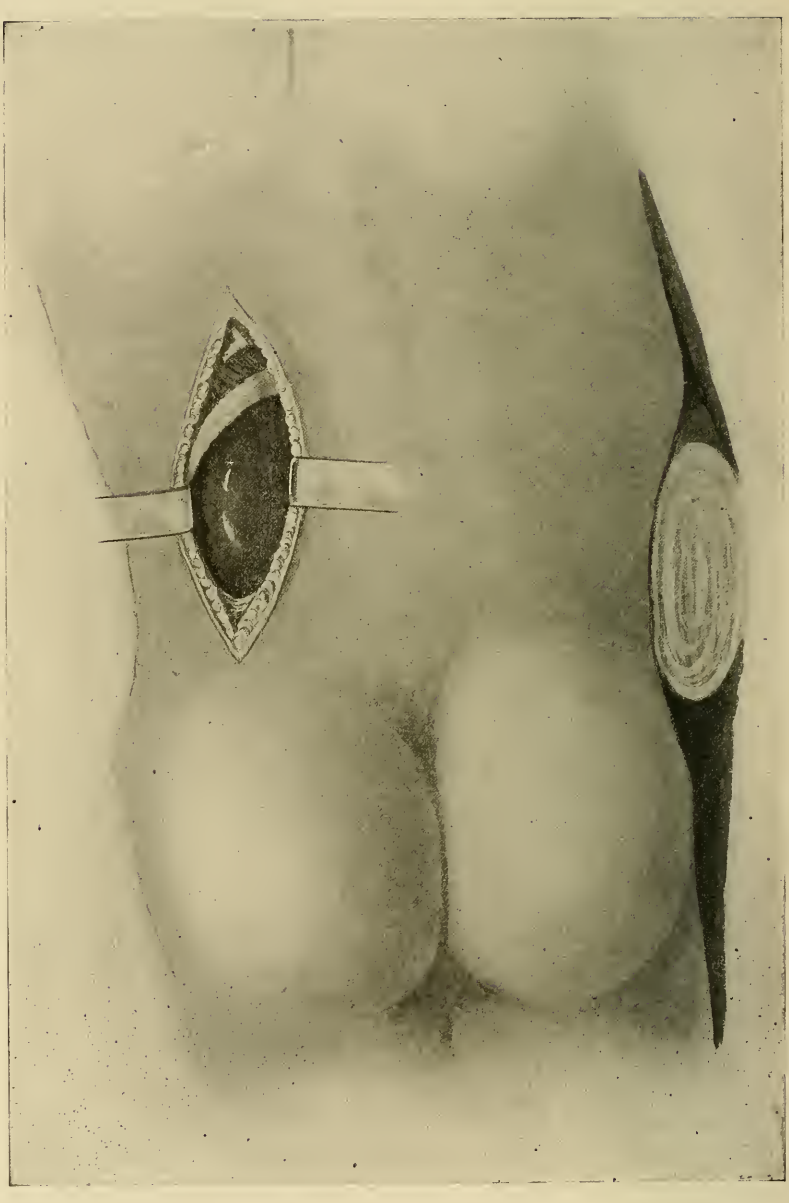


FIG. 322.—Exposure of the kidney through vertical incision. The 11th and 12th ribs are shown in the upper angle of the wound.

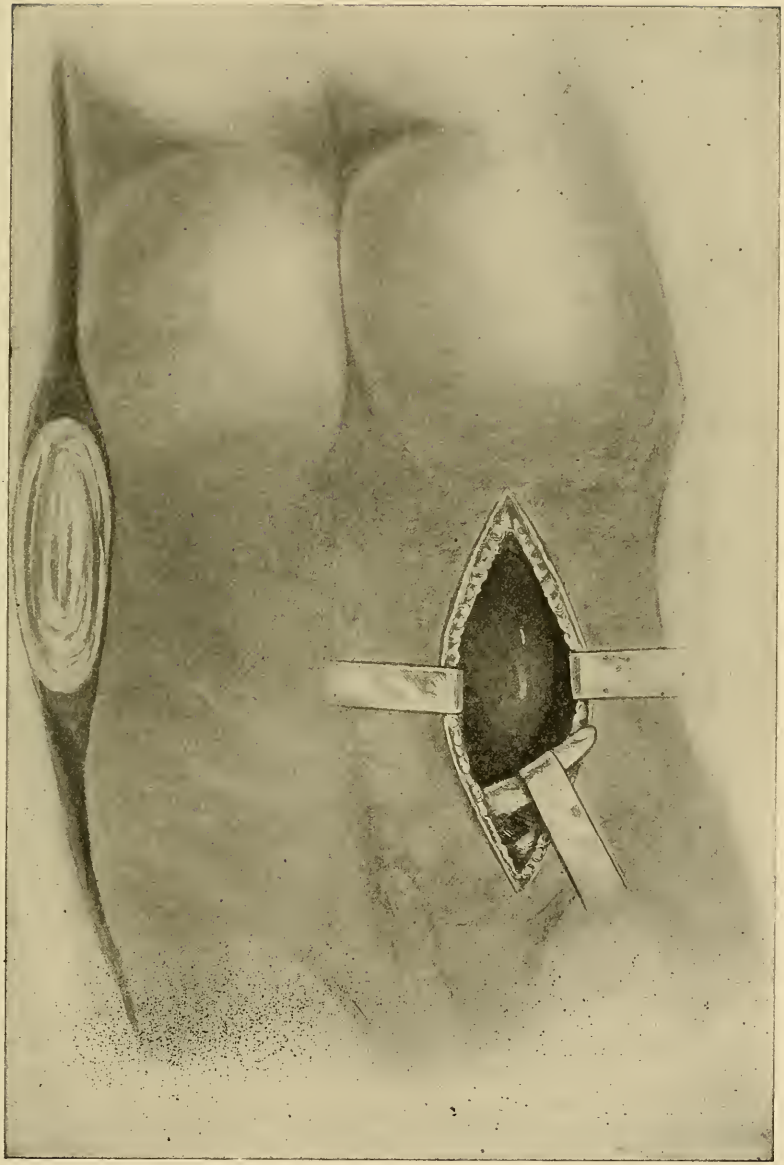


FIG. 323.—Exposure of the kidney. The 12th rib has been freed of muscular attachments and is being drawn strongly upward for better exposure of the upper pole of the kidney.

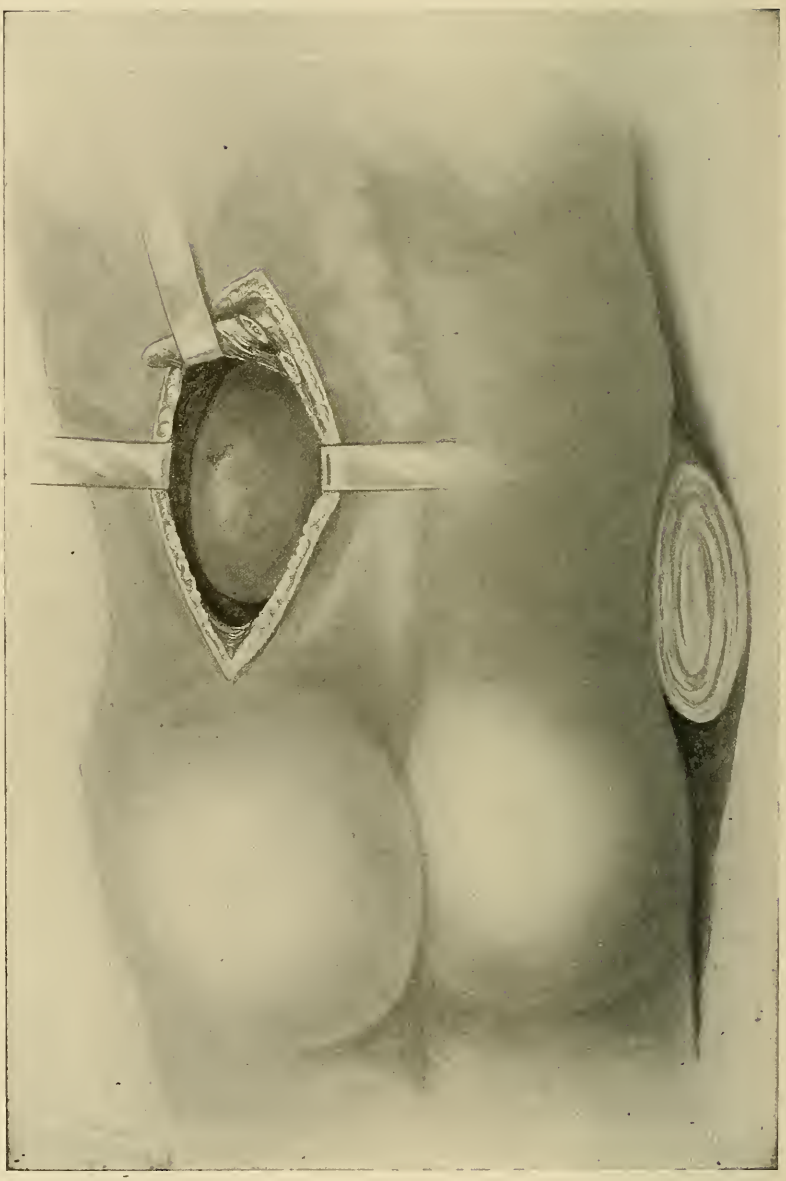


FIG. 324.—Exposure of the kidney. The 12th rib has been resected, the 11th divided and drawn upward. (Sometimes required in freeing the upper poles of very adherent kidneys.

are tied between the two instruments by a transfixing chromic-gut ligature. The proximal forceps is then removed, and a circumferentiating ligature is knotted tightly in its groove. The ureter is crushed, tied, and cauterized (Figs. 325, 326, and 327). The wound should be irrigated with sterilized water or sublimate solution and packed with sterile gauze, or it may be partially closed and drained with a rubber tube, which should be removed in three or four days.

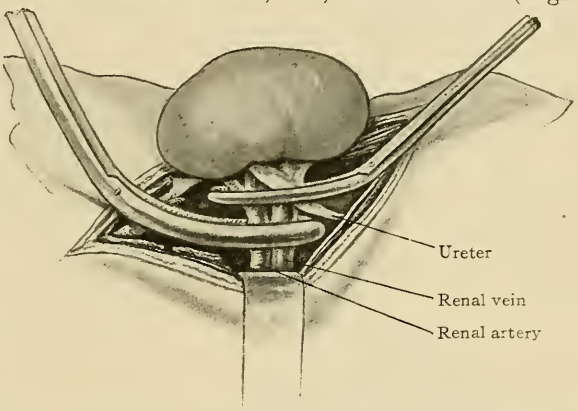


FIG. 325.—Nephrectomy. The pedicle has been doubly clamped. It is usually possible to avoid inclusion of the ureter.

TRANSPERITONEAL NEPHRECTOMY.—Nephrectomy through an incision in the linea semilunaris, known as Langenbuch's operation, is indicated when the wound has probably involved other organs and has opened the peritoneal cavity; this approach is also serviceable in the removal of tumors of large size, and in children. This incision should be at least four inches long. When the abdominal cavity has been opened, the opposite kidney is palpated, not only to make sure of its existence, but, furthermore, to ascertain, as far as possible, its condition of health and whether or not it can endure the strain of double duty. If it be absent or diseased, the operation must be abandoned. If this examination of the uninjured kidney shows that it is probably healthy, the intestines are pushed aside from the affected kidney, the outer layer of the mesocolon is exposed, and a vertical slit is cut in it over the kidney (Fig. 328), the general cavity being protected by careful gauze packing.

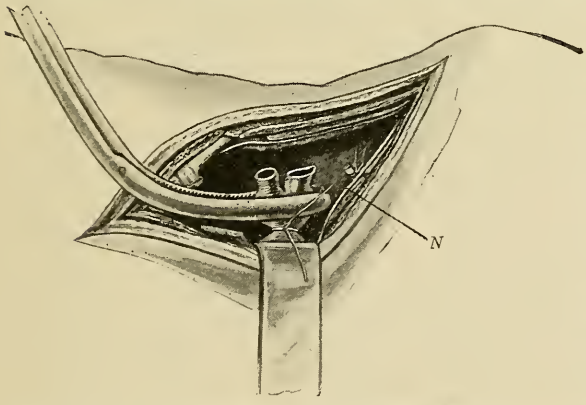


FIG. 326.—Nephrectomy. Pedicle ligated and kidney removed. When the first ligature is passed between the clamps, a second may be placed in the groove of the proximal forceps. *N*. Ilioinguinal nerve; the iliohypogastric, usually also exposed in the incision, lies posterior and is not visible.

If the peritoneum has been wounded, blood and extravasated urine are sponged out and intraperitoneal injuries are treated before dealing with the kidney, unless there is bleeding; in that case no time is lost in fully exposing the organ. The kidney is enucleated from its fatty capsule as in the lumbar operation, and the vessels and ureter are tied off and divided. It is advisable

in this operation to provide drainage through a lumbar wound for three or four days. The peritoneum overlying the kidney should be completely closed by suture, and the abdomen closed without drainage. Unless there are lesions

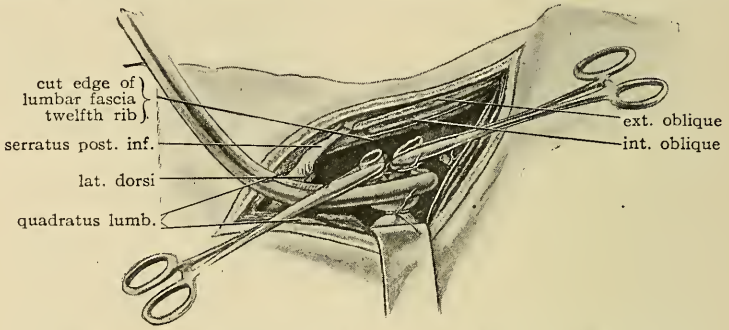


FIG. 327.—Nephrectomy. Vein and artery held apart for separate ligation.

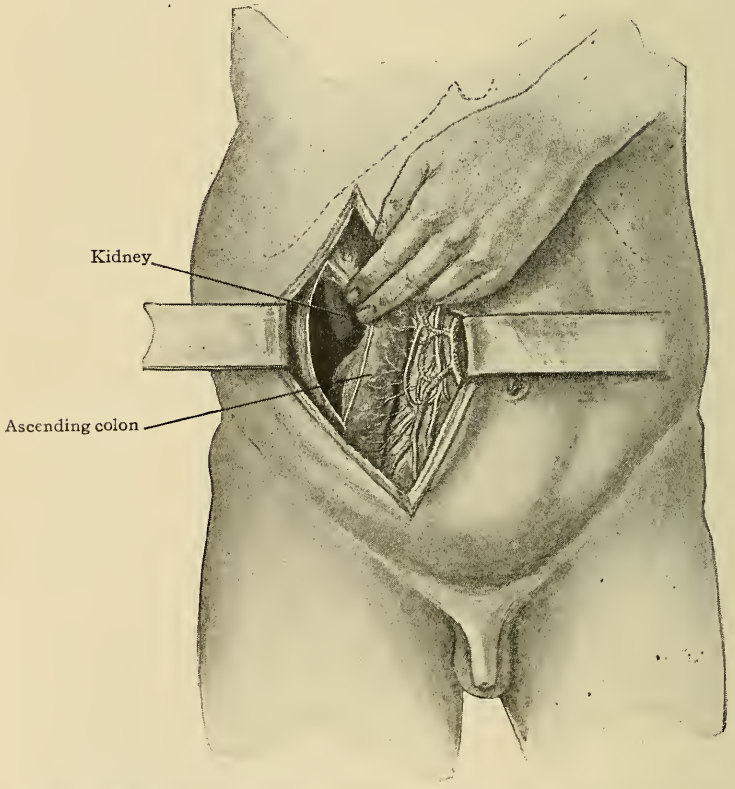


FIG. 328.—Incision of the parietal peritoneum to outer border of colon in transperitoneal nephrectomy.

of the abdominal viscera, or unless from the nature of the wound it is probable that infection will follow. When abdominal nephrectomy is performed after infection has developed, the peritoneal cavity must be freely drained.

In abdominal nephrectomy performed through an incision in the linea alba the inner layer of the mesocolon is incised in order to reach the postperitoneal kidney-space. Thereafter the procedure is the same as in Langenbuch's operation. Profuse hemorrhage from cutting one of the large veins running along the inner layer of the mesocolon frequently happens; this may be prevented by cutting in the line of the veins, or by tying beforehand those vessels which inevitably must be cut. Drainage should be secured through a counter-opening in the lumbar region.

The main advantage of the abdominal route is the opportunity it affords of examining into the condition of the uninjured kidney and of detecting and repairing associated injuries of the intraperitoneal viscera.

Subcapsular Nephrectomy.—When the fibrous capsule of the kidney is firmly adherent to the fatty capsule it may be impossible to separate the two, and be necessary to remove the kidney by stripping it from within its enveloping membrane. In doing this the capsule should be incised along the convexity of the kidney and stripped down each side as far as the hilum. A choice of procedure then lies between clamping the pedicle within the capsule, and, incising the capsule about the hilum so that it slips back over the pedicle, ligating the vessels and ureter extracapsularly. When it is found quite impossible to ligate in this manner it is proper to apply the ligature so as to include the capsule (Fig. 329); but under such circumstances it is wise to leave the clamp in place with the handles protruding from the wound, removing it on about the second day, or the clamp alone may be relied upon for the control of the vessels.

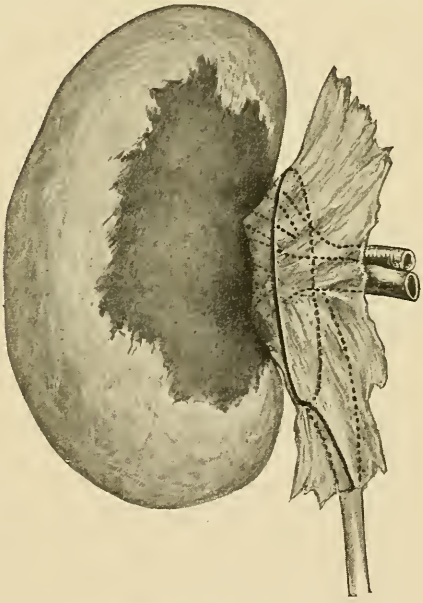


Fig. 329.—Subcapsular nephrectomy.

After loosening the clamp it is advisable to allow it to remain in the wound for ten or twelve hours before withdrawing it, thereby allowing the tissues in its grasp time to become separated from it and retract.[1] After securing the pedicle as much of the capsule as possible should be removed with scissors and forceps.

Nephrectomy by Morcellement.—This little-used method is applicable when, on account of firm extracapsular adhesions, it is impossible to reach the pedicle by the subcapsular method just described. The capsule is split and stripped from the kidney as in the preceding operation. Then a long, straight clamp is applied to the lower pole of the kidney just below the hilum, and this portion is cut away, making room for the application of a curved clamp to the lower portion of the pedicle. The upper pole is then similarly treated, and the

[1] Mayo: *Surgery, Gynecology, and Obstetrics,* 1917, xxiv, 1.

remainder of the pedicle clamped, after which the central portion of the kidney is removed. If now it is possible to apply ligatures to the pedicle, this is done as in the subcapsular operation, otherwise the clamps are left in place for four days and the wound closed about their handles.

Whatever method is used in removing the kidney, the wound should be closed with chromicized catgut sutures, so that the fascial layers are carefully approximated. It is generally best to drain with tube or " cigarette " for two or three days.

Partial Nephrectomy.—This operation is very rarely indicated; is more dangerous than nephrectomy, when the opposite kidney is in good condition, and is less likely to cure the condition for which it is performed.

The kidney is delivered, and while an assistant compresses the pedicle the operator excises a wedge-shaped piece, including the diseased area, and inserts and ties the mattress chromicized catgut sutures which shall bring the cut surfaces together. These should be placed ten to fifteen millimetres apart, and well back from the margin of the wound. Drainage should be maintained for at least a week.

Operative Complications and Accidents.—The chief of these is hemorrhage. This may arise from the tearing of an anomalous artery, most often one to the lower pole of the kidney, during the freeing of the organ from its fibro-fatty or capsular investment; from one of the vessels of the pedicle, either through injury while applying the ligature or through faulty application of the ligature; or through injury to the vena cava, which, on the right side, lies close to the kidney, and the wall of which may be seized in the clamp applied to the pedicle. Hemorrhage from accessory arteries is rarely alarming, but may be difficult to control on account of retraction of the vessel into the fat. The vessel can usually be secured; occasionally packing is necessary. Bleeding from the vessels of the pedicle may be so profuse that the patient becomes exsanguinated in a few seconds. If the kidney has not yet been removed it may be possible to draw upon it sufficiently to efficiently place another clamp. If there is no such convenient handle, the left hand should be thrust into the wound and an effort made to locate the pedicle, grasping it between the index and middle fingers; a clamp may then be passed down to secure the vessels. In such blind work there is, of course, danger of catching one of the abdominal organs, especially the duodenum. Tearing of the vena cava has been treated by tamponade, suture, lateral ligature, closure by forceps, and ligature of the whole vein. The last-named method seems to have given the best results (Guiteras).

Opening the Peritoneum.—This has occurred many times, usually without ill results, even in infected cases. The presenting organs should be sponged off with normal saline solution, and the opening closed.

Opening the pleura, characterized by the hissing sound of inspired air, is remedied by immediate suture. The slight resultant pneumothorax is of little moment. Because of the usual position of the patient during nephrectomy, such an opening may not cause even a limited pneumothorax.

Difficulty in Delivering the Kidney.—This may be caused by adhesions, the size of the organ, the shortness of its pedicle, or the conformation of the individual. In thick-muscled, short-waisted, deep-chested individuals difficulty in

this regard may be expected, and should be avoided by dividing all the lower attachments of the last rib and drawing it upward and backward, or by subperiosteally freeing and removing this bone in the early part of the operation (Judd) (Figs. 322, 323, and 324).

Duodenal Fistula.—This is a rare sequel of nephrectomy on the right side (Mayo). The descending portion of the duodenum overlies the pedicle of the right kidney. Injury is not likely to occur except where the pedicle is infiltrated, so that difficulty is experienced in proper ligation; the clamps used to control the sudden hemorrhage from a slipping vessel may then catch the duodenum and so injure it that a fistula results, usually four or five days after operation. The complication is one of great gravity, three reported cases having all died of asthenia. The accident is to be avoided by the use of an adequate incision, by care in securing the pedicle, and, in case of hemorrhage, by caution in the application of clamps; Mayo recommends securing the vessels with the fingers first, the pulsations of the artery making them easily found. Curative treatment, as suggested by Mayo, consists in a transperitoneal closure of the fistula, laying a transplant of peritoneum or omentum across the line of suture, and the formation of a temporary jejunostomy.

Anuria and uræmia, from failure of the remaining kidney to care for the needs of the organism, are of comparatively rare occurrence when due care is taken to ascertain by means of functional tests the condition of this organ. Should they supervene, hot enteroclysis, hot stupes and cups to the loin, general hot packs, and the hypodermic administration of caffeine sodio-benzoate and of pituitrin are in order. Should these fail to evoke a free flow of urine, exposure of the remaining kidney, with decapsulation, pyelotomy, or nephrotomy, should be considered.

Secondary hemorrhage is of rare occurrence, and can usually be controlled by packing with gauze. Should this fail, the bleeding point must be found and tied.

Septic Infection.—This commonly occurs to a mild degree, but rarely to such an extent as to give rise to anxiety. Routine drainage of the wound is advisable.

Sinuses, here as elsewhere, are usually kept up by the presence of some foreign material, as a silk ligature, or a low-grade inflammatory process, generally a tuberculous ureter. The removal of the former, and the treatment of the latter by tuberculin and injections of iodoform, phenol, and iodine, rarely its excision, are the measures indicated.

ANEURISM OF THE RENAL ARTERY

This rare condition is usually of traumatic origin, twelve of the nineteen cases collected by Morris having had this etiology.

The symptoms are tumor, pain, and hæmaturia. A bruit has sometimes been noted.

The treatment is nephrectomy, performed by the abdominal route should the diagnosis have been made prior to operation. Unfortunately it is rarely possible to make a pre-operative diagnosis.

CHAPTER XXVII

NEPHROLITHIASIS

The majority of renal calculi are composed mainly of the oxalate of lime. This fact has been demonstrated by the work of Rowlands, of Mackarell, Moore and Thomas, and of Kahn and Rosenbloom. Uric acid and phosphate stones occur with about the same frequency, each about one-tenth as often as the oxalate. Uric acid stones are deposited in acid urine; the others in urine with an alkaline reaction.

Stones are rarely homogeneous. Uric acid stones are more apt to be pure than are any of the others. Neither size, color, shape, density, nor character of surface can be regarded as of any value in determining the composition of a renal stone; a chemical analysis is the only reliable method.

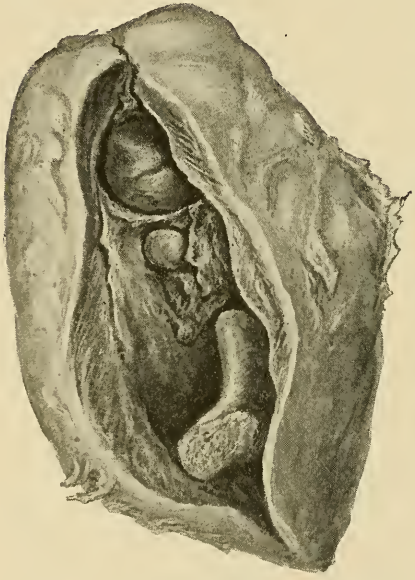


Fig. 330.—Nephrolithiasis. Branched calculi of the pelvis, exposed by cortical incision into the kidney. (From the Department of Surgical Pathology, University of Pennsylvania.)

Cystin, xanthin, ammonium urate, or other urates are rare as the principal ingredients of kidney stone. It is possible that calculi may originate in the renal pelvis about a minute clot. Exceptionally concretions are found made up almost entirely of inspissated blood. Foreign bodies serving as nuclei are extremely rare. Frank has, however, reported a case in which an ordinary sewing-needle formed the nucleus of stone which caused an extensive perinephric abscess. The needle had been swallowed in childhood, and had finally penetrated the pelvis of the kidney and there become encrusted with urinary salts. Rosenstein found a calculous deposit about a hair, evidently from a dermoid cyst of the kidney.

The number of calculi may vary from one to a thousand. In shape they are seldom round or regular, owing both to the shape of the cavity wherein they are contained and to their restricted attrition from motion. One large calculus and numerous small ones may be found filling up the renal pelvis, in which case the larger calculus acting as a ball-valve may partially close the entrance to the ureter and only occasionally allow smaller calculi to pass down. Such may be the case when frequent attacks of renal colic are followed by the

passage of small calculi per urethram, but the general symptoms do not ameliorate.

Kidney calculi are usually found in the pelvis or its branchings (Fig. 330). Exceptionally they are placed in the substance of the kidney, as in the case when the urate infarcts of the newly-born form true stones. In the absence of infection calculus is generally adherent, taking the shape of the portion of the pelvis in which it is placed, often bifurcating and branching like a piece of coral, and representing a rough mould of the pelvis and its subdivisions (Fig. 331). When infection has taken place, calculi may be found in any portion of the pelvis, perhaps most frequently in its upper and lower extremities. Both kidneys are affected in about fifteen per cent. of cases.

Pathological Changes.—A calculus of moderate size may remain indefinitely in the kidney without producing the slightest pathological change in the secreting structure. If the calculus is so placed that it suddenly and completely blocks the ureteral orifice, the kidney will atrophy. As a usual sequel there is gradual dilatation of the pelvis and its branches, due to partial obstruction. This may result in either hydronephrosis or atrophy; occasionally cystic degeneration occurs (Fig. 332). When infection has taken place—and this occurs, as a rule—there result pyelonephritis, pyonephrosis, and often secondary purulent deposits. As a complication of the kidney infection an indurative or suppurative perinephritis may develop. Stones may ulcerate into the perinephric tissue.

Etiology.—The formation of kidney calculi is due to the precipitation in the kidney tubules or pelvis of the solid constituents of the urine. This precipitation always takes place on an organic base. This may be mucus, epithelial cells, blood-clot, or colloid material. That a coagulation necrosis of cells caused by interference with the circulation favors deposition of lime salts has been demonstrated experimentally. All concrements, whether they be the size of a grain of sand or of a goose-egg, have a distinct albuminoid framework upon which the constituents of the urine are deposited. The difference between sand and sediment lies in the fact that in the former the crystals are conglomerated about this organic framework.

Stone-formation is commonly associated with the uric acid, the oxalate, or the phosphatic diathesis, an excess of these ingredients favoring a coagulation necrosis of cells, which furnishes the organic framework essential for calculus formation; the same effect is produced by local sepsis.

Heredity exerts a direct influence on the development of kidney calculi. Leroy d'Étiolles records the fact that of a family of eight brothers who lived in various parts of Europe under different conditions of hygiene all had calculi.

Uric acid kidney stones have been found in the fœtus. In general renal calculi are most frequently observed in children and after the fortieth year. The uric infarct of the newly-born, appearing as a deposition of red and brown crystals, particularly of ammonium urate, in the epithelium of the pyramidal

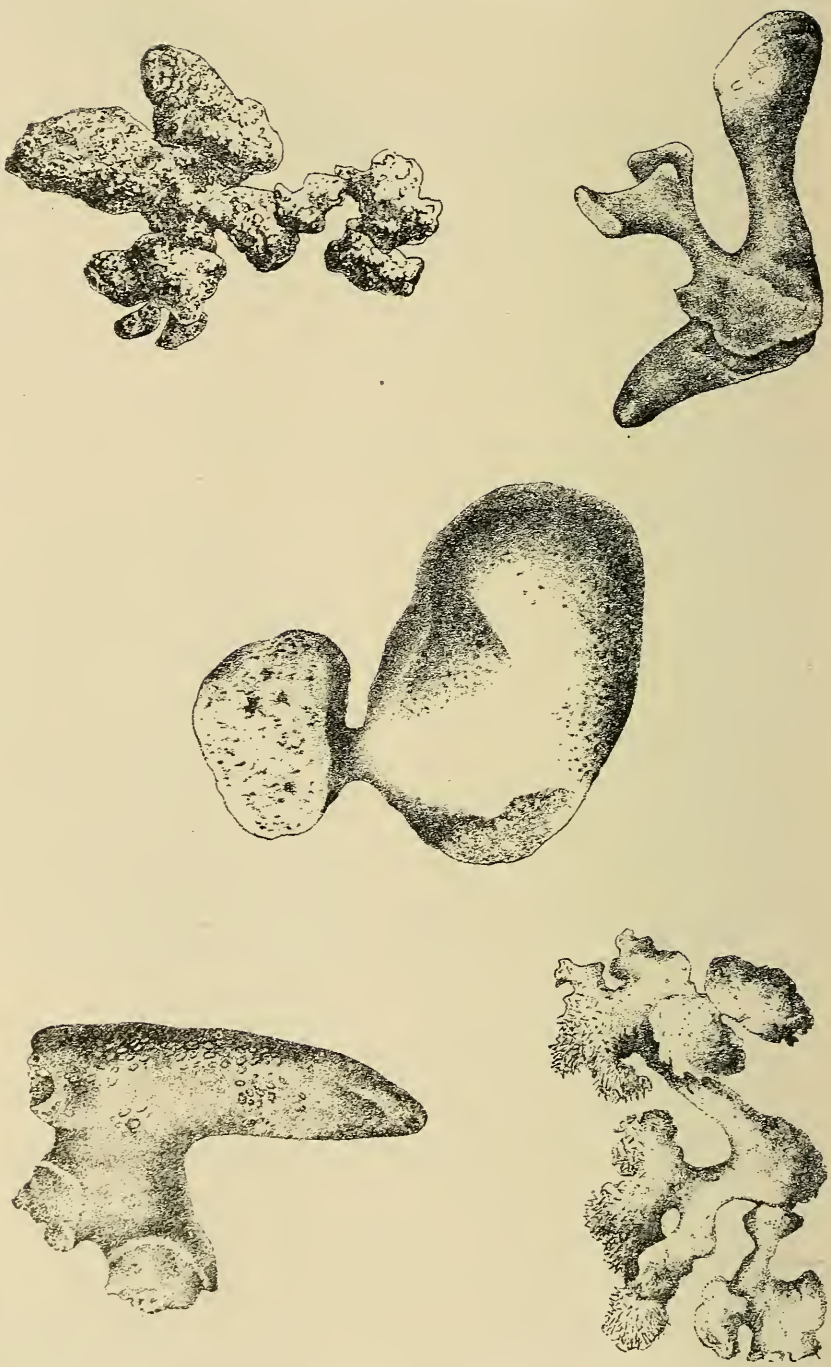


FIG. 331.—Various forms of kidney-stone, illustrating the irregularities in shape. (Torres.)

tubules, may account for the frequency of vesical calculi in children; kidney colic is, however, rare at an early age.

Renal calculi are commoner in men than in women, the ratio being given as three to one. Duplay and Reclus, however, hold that the two sexes are equally affected.

Hygienic surroundings, climate, and diet seem to have a definite relation to the formation of kidney stone, but one which has not been clearly formulated. Moist climates and sudden changes of temperature apparently predispose to calculus-formation.

FIG. 332.—Multiple bilateral renal cysts and calculi. (Specimen in Philadelphia Hospital Museum.)

Men who lead sedentary lives and indulge in high living are more liable than others to urinary concretions. The frequency with which renal calculi are found among the children of the poorer classes has been attributed to unfavorable hygienic surroundings and coarse diet.

Symptoms.—The chief symptoms of renal calculus are pain, hæmaturia, frequent urination, fragments of calculus appearing with the urine, pyuria, oliguria or suppression, and symptoms of gastro-intestinal disturbance. A stone may, however, be present in the kidney for many years, or through an entire lifetime, without producing symptoms.

The symptoms caused by kidney stone are due to obstruction rather than to the presence of a foreign body; hence the position of the stone is of more importance than its shape or size. Guyon comments on the tolerance of the kidneys and ureters to foreign bodies as contrasted to their sensitiveness to distention.

The pain of renal calculus is commonly referred to the lumbar region of the affected side. It is constant and aching in character, and is increased by motion, by jarring, and by pressure over the kidney. It begins as a feeling of weight or tension rather than as an actual pain. It is subject to sudden exacerbations, often occurring at night when the patient is completely at rest. It may be referred to the healthy kidney. Neuman reports two such cases, which were corroborated by the skiagraph and by subsequent operation. In its exacerbations it usually radiates along the course of the ureter and into the testicle, and may cause contraction of the cremaster muscle, with retraction of the gland. It may be referred to the thigh or the calf of the leg.

The reflexes of renal calculus occasionally take the form of intestinal disturbances, characterized by vomiting and violent intestinal colic. Rectal and vesical tenesmus are not rare. Urgent and painful urination is often so marked that attention is diverted from the kidney to the bladder.

Renal tenderness elicited on deep palpation is a valuable symptom. Murphy introduced what he termed "fist percussion" as a means of differentiating between a renal lesion and one of the gall-bladder or appendix. The surgeon stands behind the patient, who should be seated on the edge of the bed or on a stool, and, placing his left hand firmly on the patient's back over the supposedly sound kidney, strikes it a strong blow with his clenched fist; the procedure is then repeated on the affected side. If a lesion which causes distention of the kidney capsule be present the patient cries out with the pain. The presence of nonobstructive stones may render the percussion uncomfortable, but does not give rise to the characteristic reaction.

Attacks of kidney colic when they are recurrent and are induced by bodily activity are particularly characteristic of renal calculi (see p. 574). Perfectly typical paroxysms may, however, occur without the presence of stone. This is proved not only by the large number of cases reported in which, the diagnosis having been based mainly on this symptom, the kidney was opened and no stone found, but also by the cases in which, the kidney having been exposed to sight and touch, rhythmical contractions of the ureter were observed.

Hæmaturia is usually slight and transitory, and, except after the attacks of kidney colic, can often be detected only by microscopic examination. Clots are rare. The amount of blood in the urine is increased by jolting, walking, muscular efforts, or renal palpation; there is sometimes enough to give the urine a smoky appearance. Sometimes bright-red blood is passed, but this is much more characteristic of tumor than of calculus; this is true also of clots. Rest in bed exerts a prompt and markedly beneficial effect upon the hæmaturia. There are often found in the urine blood-cylinders—*i.e.*, casts of the uriniferous tubules made up of blood-cells; these are absolutely characteristic of hemorrhage of renal origin.

Frequent urination, a pure reflex from renal and ureteral irritation, is often a troublesome symptom during the daytime, but is relieved when the patient is at rest. Jacobson observes that nocturnal and diurnal frequency of urination, when associated with other symptoms suggesting renal calculus, indicates renal tuberculosis with extension of the process to the bladder-walls, rather than renal calculus. The frequent urination of kidney calculus is usually unattended by pain. When, together with frequency and urgency, there are marked tenesmus and suffering during and after the act of micturition, these symptoms are attributable to concomitant vesical or low ureteral inflammation.

The passage of gravel or of fragments of calculi is a symptom commonly wanting; when present it is of value as indicating kidney stone, even though its passage along the ureter does not cause kidney colic.

Diminution or total suppression of the urine lasting for a few hours is a fairly frequent symptom of renal stone. When it lasts a much longer time (calculus anuria) it should be attributed to the simultaneous obstruction of both ureters, or to obstruction of the ureter of the only functioning kidney.

Exceptionally this obstruction may begin insidiously, attracting no attention until the symptoms of uræmia set in. Even for six or eight days there may be no characteristic symptoms other than failure to pass water. After this period constitutional symptoms develop, in the form of stupor, tympany, diarrhœa, subnormal temperature, dry black tongue, often hiccough and uræmic odor of the breath.

Duplay and Reclus particularly insist upon the importance of operating promptly in cases of calculous anuria, this complication being an almost certain proof of bilateral lesion. After a trial of prolonged hot baths, warm rectal injections, abundant ingestion of diluents, massage of the ureter, the use of a continuous current of electricity, ureteral catheterization, and profound anæs-

FIG. 333.—Multiple branched calculi of the kidney. (Skiagram by Dr. H. K. Pancoast.)

thetization, should anuria persist operation is indicated. Forty-eight hours should be the longest time allowed for these palliative measures. Calculous anuria is spontaneously relieved in twenty-eight and five-tenths per cent. of cases. Sixty-six and six-tenths per cent. of operative cases recover (Legueu).

The great difficulty in these cases is to discover the seat of obstruction: palpation, the history of the case, and ureteral catheterization and the X-ray may determine this. The incision should be the lumbar one, and the whole of the ureter should be exposed if this be necessary.

Gastro-intestinal disturbances are either reflex or due to imperfect elimination on the part of the crippled kidneys. Tympany, vomiting, and exquisite tenderness at times complicate and greatly obscure attacks of renal colic. Chronic epigastric tenderness, feeble digestion, and constant pain may direct the attention entirely away from the kidney

Pyuria is a sign of pyelitis or pyelonephritis; it is classed as a symptom of kidney calculus simply because it is so frequent a complication; infection markedly aggravates the pain, the reflexes, and the other symptoms already described; it also causes fever and favors the development of pyonephrosis.

Diagnosis.—The diagnosis of kidney stone is based on lumbar pain with intercurrent attacks of nephritic colic, slight albuminuria with hyaline casts,

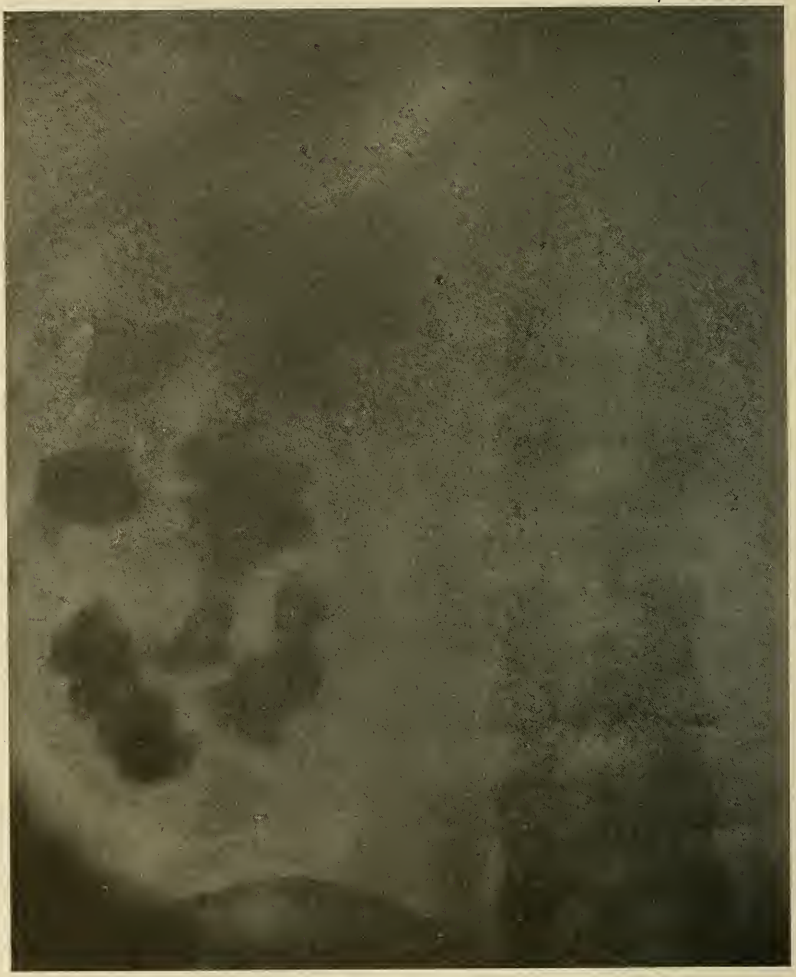


Fig. 334.—Multiple renal calculi. (Skiagram by Dr. H. K. Pancoast.)

hæmaturia, the passage of gravel or of fragments of calculi, renal tenderness, and the use of the X-ray. These symptoms are rarely all present. Pain and hæmaturia are the two most constant, and, with the exception of the passage of calculous fragments, the most characteristic. The X-ray is the most valuable means at our disposal for determining the presence and position of renal calculi (Figs. 333, 334, and 335). The only cases in which the X-ray expertly employed

is apt to fail to reveal a stone is in the case of calculi composed largely of uric acid. Care must be exercised to exclude the presence of any substance in the intestine capable of throwing a shadow which might be mistaken for a stone. For this reason a purge should be given the day before the skiagram is made

FIG. 335.—Calculus impacted in the pelvic end of the ureter. (Skiagram by Dr. H. K. Pancoast.)

(two compound cathartic pills, crushed, have proved satisfactory), and breakfast should be omitted. Tenderness may be elicited either by palpation or by directing the patient, while in a standing position, to strongly flex the thigh of the affected side and then suddenly extend it, bringing the heel forcibly to the floor. If a calculus be present, this movement, called the stamping test, may cause

sudden acute renal pain (Lucas). Movable kidney often causes constant pain and acute exacerbations precisely like those which arise from stone. Sometimes blood is mixed with the urine, but only after an acute attack of pain; the movable kidney can sometimes be felt in its abnormal position. The comparison of functional tests performed on the two kidneys is sometimes a deciding point.

Commenting upon the difficulty of recognizing the presence of stones in the kidney and ureter, Cabot [1] notes that the records of 153 patients operated upon for these conditions in the Massachusetts General Hospital showed that in 26 cases abdominal operations had previously been performed without relief of symptoms. In these cases the prominent symptoms were pain in right lower abdominal quadrant (12 cases), abdominal pain without colic (13 cases), and backache (11 cases). Urinalysis was entirely negative in 14 per cent.; the X-ray was negative in 6 per cent. But pain, or urinary abnormalities, or a positive X-ray were present in every case.

Nephralgia may simulate renal calculus in all respects except in the presence of blood or pus in the urine, though Sabatier states that this affection also causes hæmaturia. Large quantities of limpid urine of low specific gravity are passed; the suffering is aggravated at the catamenia.

Tuberculosis of the kidney in its early stages may simulate renal calculus. There is hæmaturia which is apparently causeless, and the characteristic reflexes develop. Renal tuberculosis is often associated with hereditary dyscrasia and with tuberculous infiltration of the epididymis, prostate, and vesical walls. Moreover, repeated and patient examinations and inoculations will usually show the tubercle bacilli in the urine. Tuberculous kidney seems more subject to mixed infection than is the case in calculous kidney: hence there is often a great deal of pus in the urine; this may be thick and contain caseous particles, which rapidly settle to the bottom of the vessel in which the urine has been passed.

Malignant growths are characterized by hæmaturia much more pronounced than that due to calculus, clots often appearing in the urine in the shape of ureteral moulds; the growth rapidly and steadily increases in size.

Oxaluria and strongly acid urine cause dull ache, paroxysmal pain, and hæmaturia. The pain is, however, not materially increased on exertion, the tenderness is not distinctly marked on deep palpation, and treatment is followed by prompt relief.

Pyelitis cannot be distinguished from renal calculus with infection except by the history of the case and the X-ray. Pain is not likely to be so distinctly paroxysmal.

Spinal caries involving the lower dorsal or the lumbar vertebræ may in its symptomatology closely simulate kidney stone. Thus, Wright reports a case characterized by increased frequency of urination, intermittent attacks of pain causing nausea and vomiting, testicular pain, local tenderness, and oxaluria. An abscess had formed and by pressure on the kidney had caused symptoms of calculus.

The distinction between kidney stone and gall stone may usually be made by Murphy's fist percussion (see p. 622). The anterior position of the pain

[1] *Surg., Gynec., and Obstet.*, 1915, xxi, 403.

and tenderness with backward and upward radiations, the absence of blood or pus from the urine, the abundant secretion during the attack, and a preceding history of persistent gastro-intestinal disturbances and attacks of jaundice would all suggest hepatic colic.

Appendicitis has frequently been confounded with renal calculus complicated by hydro- or pyo-nephrosis, but is characterized by the seat of the tenderness and tumor, the persistent character of the pain and gastro-intestinal disturbances, the unmistakable rigidity of the right rectus muscle, the absence of blood and pus from the urine, and the pronounced pyrexia and leucocytosis. Marked flexion of the thigh is more common in renal colic than in appendicitis.

Locomotor ataxia and hysteria may produce symptoms closely simulating those of renal calculus. Examination of the urine should exclude kidney stone.

In thin persons, and when there are many concrements (Fig. 334), on palpation both tumor and crepitus can be detected, the latter particularly by combining palpation with auscultation. This is, however, exceptional.

The most characteristic diagnostic symptoms, placed in their order of importance, are an unmistakable skiagram, passage of gravel or of fragments of stone, attacks of typical renal colic, hæmaturia, and ultimately pyelitis. It is clear that prolonged study of the urine is necessary before forming a diagnosis, the results of this study often sufficing to exclude affections which simulate renal calculi.

It is of extreme importance to determine whether one or both kidneys are calculous, and if but one kidney is affected, whether the other is healthy. This is to be done by means of the X-ray and tests of the functional power of the two kidneys.

The final diagnosis of kidney calculus, and this is always justifiable when the integrity of the kidney is seriously threatened and when the patient's health is progressively failing, is direct exploration of the kidney pelvis by means of a lumbar opening. When a stone cannot be felt, needling may be resorted to; if this be unsuccessful, the pelvis should be opened and explored by means of finger and probe. When there is any doubt as to the condition of the remaining kidney, both organs should be exposed.

Prognosis.—In the absence of symptoms of obstruction or infection the prognosis of kidney stone is guardedly favorable. Though the foreign body may remain years in the pelvis or calices of the kidney, causing no symptoms other than occasional hæmaturia or perhaps pain, there is a slow progression of interstitial nephritis which ultimately cripples the secreting power of the organ. When obstruction develops, if it is transitory, due to the passage of a stone into the bladder, and is completely relieved by the escape of the calculus, the urine not persistently showing albumin and hyaline casts, the prognosis is still favorable. When the obstruction is not promptly relieved, but becomes chronic, with recurring acute exacerbations, the prognosis as to the integrity of the kidney is grave. When infection takes place, the prognosis is always grave unless prompt operation is practised. The combination of obstruction and infection imperatively calls for operative interference.

Treatment.—The preventive treatment of kidney calculus is indicated when the passage of sand or gravel, or a microscopic examination of the urine, shows

that there is an excess of solid constituents. In case the sediment or sand is made up of uric acid, out-of-door exercise, abstinence from alcoholic drinks, baths and surface friction, careful regulation of the diet, and the ingestion of large quantities of water, particularly Carlsbad, Friederichshall, and Londonderry, are indicated.

When the sediment is made up of calcium oxalate, in addition to exercise, diet, and diluents, acid sodium phosphate is of service. Likewise all other deposits from alkaline urine require treatment directed either against alkaline dyspepsia or local infection.

Patients subject to lithiasis should eat sparingly, should especially avoid dark meats, sugars, highly seasoned food, rhubarb, tomatoes, asparagus, and strawberries, Burgundy, champagne, and malt liquors. They should drink freely of pure waters, which by decreasing the proportion of salts in the urine lessen the formation of new calculous material, and by increasing the volume of urine aid in the discharge of any that has already been deposited in the kidney. Potassium citrate, lithium carbonate, and sodium phosphate are the most valuable alkaline diuretics. These drugs may be given in doses of from five to twenty grains three to six times a day well diluted. Moderate exercise is highly desirable, but it should not be carried to the point of extreme fatigue or excessive perspiration. All excesses should be avoided, especially those which may be followed by gastro-intestinal or hepatic disturbances.

Palliative treatment for severe pain, particularly that characteristic of renal colic, is mainly limited to the free use of anodynes (see under " Diseases of the Ureter," p. 578).

Nephrolithotomy.—The absolute indication for the performance of nephrolithotomy is the presence of a stone in the renal pelvis or its branchings too large to pass through the ureter into the bladder. Such a condition, proved by the X-ray, is suggested by harassing, persistent pain, with frequent overwhelming exacerbations, hydronephrosis, pyonephrosis, hyaline casts, albumen in the urine, and anuria. The route chosen is, with few exceptions, the lumbar one. The single advantage presented by the abdominal incision is that it allows of exploration of both kidneys. The incision for exposing the kidney is that already described (Figs. 316 and 317). The patient is placed either on his sound side in the half ventral decubitus with a roll beneath the loin, or in the full ventral decubitus with Edebohls's air-cushion eight inches in diameter lying with its centre of maximum pressure a little above the umbilicus. The incision is carried from the angle made by the twelfth rib and the erector spinæ muscle—*i.e.*, from the lower border of the twelfth rib two inches from the middle line of the back, downward and forward for four inches, parallel to the rib and toward the umbilicus, cross-cutting the anterior portion of the latissimus dorsi, and the upper part of the serratus posticus inferior; partially splitting and obliquely cross-cutting the external and the internal oblique muscles. Between the latter and the transversalis (lumbar) fascia the last dorsal nerve and intercostal artery are usually encountered; the former should be preserved if possible. The outer border of the quadratus lumborum muscle is then retracted and the anterior layer of the lumbar fascia and the fascia transversalis are transversely split, exposing the fatty capsule. If the first incision does not

allow of full exposure of the kidney to both palpation and inspection, and this is possible only when it is large enough to admit the surgeon's hand, it should be enlarged both upward and downward, the last rib being freed and retracted or broken, or excised as needful. The perinephric fat is opened widely, and the kidney is thoroughly exposed through its entire surface and is drawn well into the wound by traction on the perinephric capsule, supplemented, when the ventral decubitus and the air-cushion are used, by so pulling the patient's ankles that the air-cushion placed beneath the abdomen is rolled from below upward (see p. 316). The kidney is then palpated by the fingers of the two hands placed on either side, special attention being devoted to the hilum and to the two extremities. If the calculus cannot be detected by this means,—and this may well be the case, since even after the kidney has been removed from the body palpation has failed to detect a stone in its substance,—an incision should be made through the kidney-substance. The incision which will cause the least possible hemorrhage must be made in the line of separation

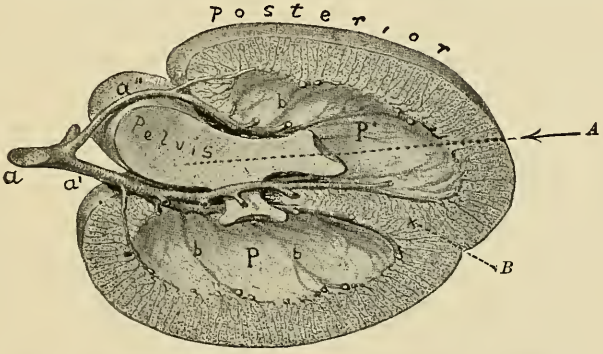


FIG. 336.—*A*. The proper position for the incision. (Brödel.) *B*. Brödel's white line.

of the two vascular systems and must not be angled towards the centre of the kidney (Figs. 309 and 336). Usually this vascular area lies parallel to Brödel's white line and one centimetre away from it towards the posterior surface of the organ (Fig. 337). The bleeding is often alarmingly profuse, but is usually checked by packing or the use of hot water. The kidney pedicle may previously be clamped either by the fingers of an assistant, by a padded clamp made for the purpose, or by means of a strip of rubber dam used as a tourniquet, but this is not essential. The incision should be large enough to permit the finger to be introduced into the pelvis. The cavity of the latter can now be thoroughly explored, and this exploration may be aided at times by a metal sound. This instrument, however, must be used with great care. Preceding incision doubt in regard to the position of the calculus may be removed by means of exploratory punctures with a fine paper-pointed needle. Kelly advises distention of the renal pelvis by means of a ureteral catheter and an antiseptic solution before opening into its substance. Thus Brödel's line is made more prominent, and sacculations of the cortex may be more readily detected. The gush of fluid also denotes that the pelvis has been opened.

The pelvis and calyces are explored by a stone-searcher, such as is used for the exploration of the bladder of children. After exploration of the calyces and pelvis, the ureter should always be examined by means of a ureteral catheter.

The stone, having been found, is readily removed, provided it be small and fairly regular in shape. For this purpose either the scoop or forceps is employed. Branching, coral-like stones may require fragmentation. Stones deeply placed in the pelvis may be thrust up by pressure of the fingers working from the outside. Mortar-like concrements may be removed by the douche and scoop.

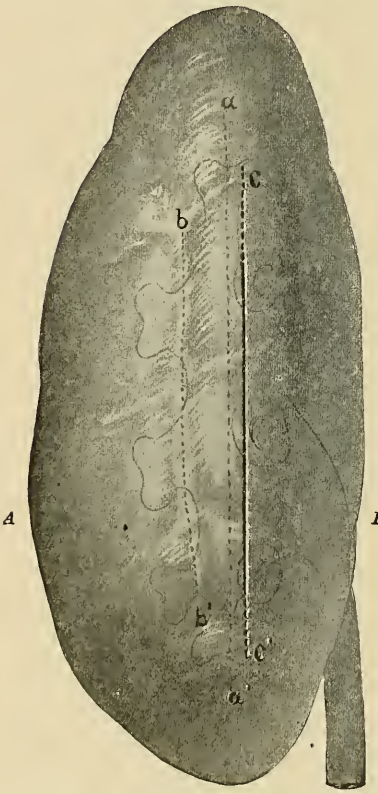


FIG. 337.—Lateral view of kidney. *b-b'*, Brödel's white line; *a-a'*, mid-line of kidney; *c-c'*, line of incision. (Brödel.)

After extracting the entire calculus it is well to flush out the pelvis and calyces with a stream of normal saline solution flowing under strong pressure (eight feet) from a comparatively large nozzle. The kidney-wound is then sutured, usually by No. 2 mattress chromicized or iodized catgut passed through the capsule and kidney-substance down to the pelvis or the walls of a dilated calyx, but not including the mucous membrane (Fig. 338). These sutures are tied down with moderate tension, and, providing they have been placed deeply, effectually stop bleeding. The kidney-wound is not drained. The parietal wound is closed by careful suture of the muscles with chromicized catgut. A drainage-tube should be carried to the kidney-wound in the majority of cases.

Pyelotomy.—In the majority of cases it is possible to remove stones from the kidney through an opening in its pelvis without cutting the parenchyma of the organ. For the performance of this operation the kidney must be delivered and the posterior surface of the pelvis exposed and freed from fat. A longitudinal incision is then made, care being taken not to injure a large vessel which commonly crosses the pelvis just within the hilum. The stone or stones having been removed by means of forceps, and the ureter explored, the wound in the pelvis is closed with a few catgut sutures, thereafter reinforced by a second line of sutures approximating the fibro-fatty investment, the kidney replaced, and the parietal wound closed in the usual manner.

When the secreting substance of the kidney has disappeared and is represented simply by a sac in which a large calculus is contained, nephrectomy is indicated. If there be doubt as to the condition of the opposite kidney this may be performed as a second operation,—*i.e.*, some weeks or months after removal of the stone, and after taking every means of making certain that the other kidney is competent to act for both.

When infection has taken place, the parietal incision is the same as that for nephrolithotomy, but the incision into the kidney is made at the thinnest and most accessible portion of the tumor. Since infection is usually complicated by pyonephrosis, there may be a large sac with diverticula, making the finding and removal of a stone extremely difficult. It is in these cases particularly that the sound is serviceable. It often happens that the calculi are either not found at all, or, if found, are only in part removed.

In the after-treatment of these wounds lumbar drainage is always indicated. Fistulæ are prone to persist in the track of the drainage-tubes.

When stones exist in both kidneys Mayo [2] advises operating first on the side with the better function; the worse side may demand nephrectomy, or operation may be found to be unnecessary when the trouble in the better kidney has been remedied. Kidneys badly disorganized by infection are best removed

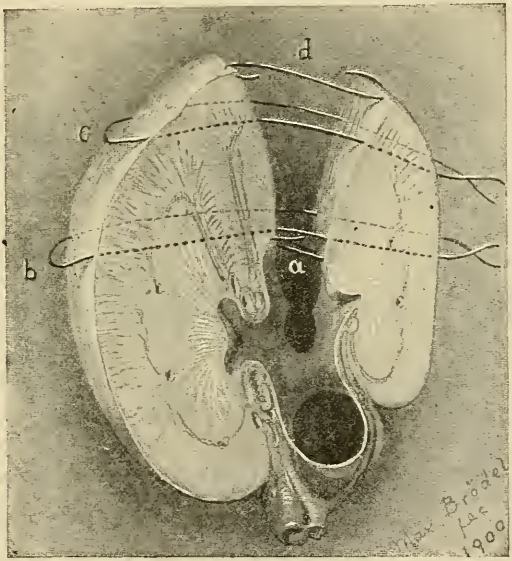


FIG. 338.—Method of suturing split kidney. (Brödel.)

when the function on the opposite side is adequate, as a recurrence of stones is frequently noted in such cases. When conservatism is needful, the pelvis should be drained by means of a tube passed through the kidney-substance, while those calyces which approach the surface should be incised and drained separately (tubes or cigarette drains).

Nephrolithotomy performed before the advent of suppuration is attended by a mortality of less than four per cent. After suppuration the mortality is much greater, and a large percentage of cases are troubled by permanent fistula.

It frequently happens that persistent renal symptoms, particularly hæmaturia, pain, and recurrent colic, are entirely cured by nephrotomy, even though no stone or other cause for symptoms be found at operation. This is so well recognized that the operation is indicated by the wearing persistence of symptoms which do not yield to conservative treatment.

[2] *Surgery, Gynecology and Obstetrics,* 1917, xxiv, 1.

CHAPTER XXVIII

RENAL INFECTIONS

The suppurative diseases of the kidney may be arranged in two groups. In the first group belong those suppurations the microbes of which enter the kidney through the artery, vein, or lymphatic channels, or extend by contiguity from the perinephric tissue. In the second group are those suppurations which are due to ascending infection along the ureter.

Hæmatogenous infection of the kidney is nearly always secondary to pyogenic foci elsewhere, such as furuncle, carbuncle, tonsillar abscess, and parotitis; septic material ascending the vena cava may enter the kidney and produce suppuration. Exceptionally it is impossible to locate a primary focus; in such cases we must assume that microörganisms circulating in the blood have attacked the kidneys first.

Traumatic suppuration of the kidney, unless the result of a penetrating wound, must be classed with hæmatogenous infections, since, in the absence of bacteria, concussion or contusion of tissue cannot produce suppuration. It is evident, however, that the injury prepares a suitable culture-field for circulating microörganisms.

It is often impossible to distinguish between lymphatic infection and infection due to extension by contiguity. As causes of secondary infection may be mentioned appendicitis, perityphlitis, parametritis, caries of the vertebræ, sacrum, or pelvis, deep colonic ulceration, abscess of the liver or spleen, subphrenic abscess, and urinary infiltration (rare). All these inflammations may extend to the kidney, involving both this gland and its fatty capsule.

The microörganisms commonly causative of renal suppuration are the members of the colon group, the micrococcus aureus, the streptococcus pyogenes, and the proteus Hauseri. Exceptionally infection is due to the gonococcus, the bacillus typhosus, the diplococcus pneumoniæ, the bacillus ulceris cancrosi, the bacillus of Friedländer, the bacterium pseudotuberculosis rodentium, the tubercle bacillus, actinomyces, and the microörganisms of acute infectious diseases. It should be borne in mind that pyelitis is common in the course of the various infectious diseases, and may become membranous.

Several facts must be emphasized in relation to the renal suppurations which result from ascending infection. Obstruction in the urethra, bladder, or ureter which interferes with the outflow of urine produces conditions favorable to infection, though it will not in itself cause suppuration. An aseptic ligation of one ureter causes atrophy of the kidney, but a septic ligation gives rise to suppuration. Traumatism, alteration in the character of the urine, or the elimination of irritating drugs, such as cantharides, produces congestion, but never septic inflammation. All causes which occasion acute or chronic congestion predispose to infection. There is some uncertainty as to the manner in which infections in the bladder spread to the kidney, experimental work seeming to show that in many instances it takes place through the paraureteral lymphatics.

Clinically, obstruction and the consequent alterations in the urine are the conditions which most frequently render the kidney and its excretory channels favorable culture-media for pyogenic microörganisms. As a rule, the healthy mucous membrane of the urogenital tract resists septic infection, but it will not always do so, nor is it necessary that there should be obstruction in order that septic matter in the bladder may infect the pelvis of the kidney. Under certain circumstances intestinal bacteria may obtain an entrance into the kidneys without any discoverable break in the continuity of the tissues.

The methods by which bacteria may reach the kidneys from below are—through the urine; by extension along the mucous membrane or the lymph-channels of the ureters; by penetration into the pelvis or ureter from the tissues surrounding the urinary tract.

In accordance with its location and clinical course renal suppuration is termed pyelitis, pyonephrosis, pyelonephritis, suppurative nephritis, and perinephritis.

Pyelitis, or inflammation of the kidney pelvis, may be secondary to nephritis (descending), or to ureteritis (ascending), or rarely to perinephritis (contiguity); the ascending inflammation is the common form.

The most frequent predisposing and exciting causes of pyelitis are—(*a*) the infectious diseases; whether in these cases the local inflammation is due to microörganisms, toxins or alterations in the urine has not been determined; (*b*) traumatism, a rare but undoubted cause; (*c*) exposure to cold; (*d*) drug irritation, as from the irritating diuretics, the balsams, the ethereal oils; (*e*) nephritis, particularly the interstitial nephritis of the gouty; (*f*) venous congestion, due either to general stasis or to local stasis, as in chronic valvulitis, pregnancy, movable kidney, abdominal tumor; (*g*) perinephric inflammation; (*h*) mechanical irritation of gravel or calculus; (*i*) tubercle, malignant disease, parasites; (*j*) and, most important of all, cystitis, particularly when it is associated with obstruction.

Pyelitis is usually bilateral. It varies in degree from a superficial catarrhal inflammation to a deep infiltrating destructive process. In the absence of infection there is often a congestion of the mucous membrane of the pelvis unassociated with desquamation of epithelium or suppuration. Such a condition may be caused by irritating conditions of the urine.

Catarrhal pyelitis may be acute or chronic. In the acute form the mucous membrane is swollen and congested; there are patches of desquamation; in severe cases the surface is covered with thick mucus mixed with blood, in which the crystals of the urinary salts are deposited. In chronic pyelitis the mucous membrane is dark in color, there is a serous infiltration of the submucoid tissues, with interstitial overgrowth, many small mucus-cysts may be formed, and in some cases the lymph-follicles become much enlarged and prominent (pyelitis granulosa) (Fig. 339). The surface is often covered with a tenacious altered mucus, and there is general desquamation of epithelium. Ulceration may be present, which may extend through the coats of the pelvic wall, giving rise to abscesses or even to infiltration of urine. Any pyelitis may become membranous, particularly when ammoniacal fermentation has taken place. Indeed, a strictly catarrhal pyelitis is rare.

When the pus of pyelitis blocks a ureter, pyonephrosis or pyelonephritis results. Parenchymatous, or more commonly interstitial, nephritis is frequently caused by pyelitis; the contracted kidney of pyelitis, however, differs from a primary contracted kidney in that the preponderance of fibrous overgrowth is in the medullary substance instead of in the cortex. Amyloid degeneration may occur in one or both kidneys when suppuration is profuse and long continued.

Symptoms.—In many cases, as is evident from the list of causes, the symptoms of a pyelitis are lost in those of the antecedent disease. In simple congestion of the pelvis pain in the loins and frequent urination are the only symptoms.

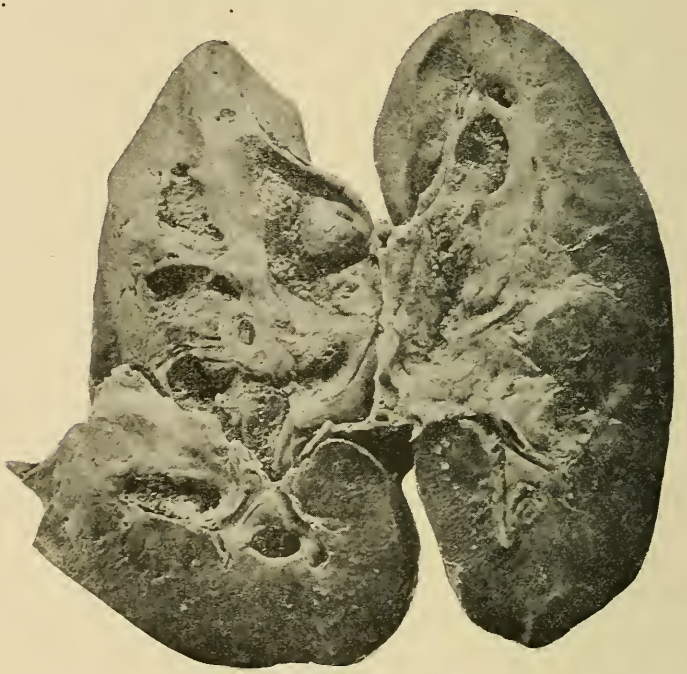


FIG. 339.—Pyonephrosis. Observe the dilatation of the calyces and note, furthermore, the chronic granulations covering the mucosa (pyelitis granulosa). (From the Laboratory of Surgical Pathology, University of Pennsylvania.)

In acute catarrhal purulent pyelitis the pain is often severe, and may present acute exacerbations; the kidneys are tender on pressure, and frequency of urination is marked. The quantity of urine is usually decreased, and exceptionally reflex anuria may supervene. The pain is increased by motion, by deep respiration, or by coughing, and may be reflected down into the penis and testicle or up towards the shoulder.

Vomiting is not uncommon. Fever develops, and there may be chills followed by profuse perspiration. As a rule, the kidneys, though tender, are not enlarged in acute pyelitis.

The urine is generally acid, and contains a trace of albumen, degenerated epithelium, and often blood and hyaline casts.

Acute pyelitis and pyelonephritis, due to the colon bacillus, are common, though usually overlooked, in infancy; pyuria of nonvesical origin, renal tenderness, chills, fever, and gastro-intestinal disturbances are characteristic symptoms.

In *chronic pyelitis* the symptoms are usually less pronounced. The pains are not so marked, nor are the organs so tender on pressure. Fever, if present, is likely to be intermittent. The kidney is not palpably enlarged unless there is pyonephrosis. There is a general impairment of health.

The urine is increased in amount, is acid or neutral, and contains nucleo-albumen, pus, and epithelium in abundance; blood is rare. As in the acute form, hyaline casts are common, but in a pure pyelitis granular casts are rarely seen. If only one kidney is affected, there may be periods when, owing to obstruction of the diseased pelvis, the urine will be normal. Calculi not infrequently form in chronically inflamed pelves. Many cases of chronic pyelitis are overlooked till irremediable kidney disorganization has occurred.

Diagnosis.—Pyelitis must be distinguished from renal and from vesical inflammation. In pyelitis the albumen is dependent upon the blood and pus, in nephritis it is essential. Granular casts are usual in kidney disease, they are not found in pyelitis. The large amount of nucleo-albumen is quite distinctive of pyelitis. The leucocytes in the urine of nephritis are often mononuclear, those of pyelitis are polynuclear. The pain of nephritis is insignificant, while acute severe pain occurs in nearly all cases of pyelitis. The differential diagnosis between pyelitis and pyonephrosis, or pyelonephritis, or acute suppurative nephritis is in some cases impossible, though the greater tendency to marked constitutional symptoms and palpability when the kidney proper is involved usually serves to differentiate the latter from pyelitis.

Cystitis suppurates more freely than pyelitis, and the urine is more likely to be alkaline and contains a much smaller percentage of albumen (one-tenth per cent., as contrasted with three times as much in pyelitis. Rosenfeld). A cystoscopic examination will prove the presence of inflammation, and ureteral catheterization will show that the urine contains no pus till it reaches the bladder. Such an examination may be required before the origin of pus can be positively determined. The importance of this becomes evident when it is realized that in the absence of ureteral obstruction polyuria and pyuria are the most constant and reliable signs of chronic pyelitis. Bazy regards nocturnal pollakiuria as the most important of all signs for the differentiation of pyelitis.

Prognosis.—Acute congestion and chronic congestion of the kidney pelvis are dangerous only because they predispose to infection. Acute catarrhal or purulent pyelitis is generally self-limited unless the infection has spread to the kidney-substance, the period of disease varying from a few days to a few weeks. The prognosis and duration of chronic pyelitis depend obviously upon the cause. When the disease develops without appreciable cause, or when it is associated with incurable obstruction or an inveterate gouty diathesis, the prognosis must be guarded.

Treatment.—The treatment of pyelitis varies in accordance with the cause, and is also dependent in a measure upon the character of the inflammation. Slight cases, such as those which develop after the exanthemata, are treated

by rest, liquid diet, and the ingestion of diluents. The natural tendency of this form of inflammation is towards recovery. When the symptoms are sufficiently severe to excite some constitutional reaction and to cause local pain, counter-irritation, local depletion, hot baths, the administration of soothing or stimulating diuretics, and careful attention to the condition of the skin are indicated. Pain should be relieved by morphine given hypodermically. Inflammation due to mechanical causes, such as calculus or stricture, prostatic enlargement, or any obstruction to the free flow of urine, can be cured only by surgical intervention. Should this become necessary in the course of acute pyelitis, it must be borne in mind that there is always great danger of converting a simple pyelitis into a pyelonephritis or "surgical kidney"; hence every antiseptic precaution should be taken.

If the bladder be the seat of inflammation, vigorous treatment of the cystitis may effect a cure. Cabot has pointed out the value of the indwelling catheter.

The operative procedures should be preceded by the administration of urinary antiseptics,—namely, salol and urotropin in full doses, the urine being acid.

The development of pyelitis as a complication of any obstructive lesion of the urinary tract, regardless of its seat or cause, is a sufficient ground for operative interference when this offers any promise of permanently overcoming the obstruction. The operation should be performed early, since pyelitis associated with obstruction means inevitable destruction of the secreting substance of the kidney.

Kelly, Pawlik, and others have treated chronic pyelitis by the mouth administration of urinary antiseptics (salol and urotropin) and diluents, and by drainage, instillation, and irrigation. This treatment is particularly indicated in cases developed as a consequence of hæmatogenous or of ascending infection; but in the latter case only after the cure of the lesions of the lower tract. Protargol, in one to five per cent. solution, is used for instillation, the same drug, 1 to 2000, or boric acid, 1 to 500, for irrigation, the treatments being repeated twice weekly till pus has disappeared from the urine. Thereafter prolonged dietetic and hygienic treatment is indicated. Treatment with autogenous bacterins sometimes produces brilliant cures, and should be tried before resorting to more formidable measures. When, in spite of medicinal and dietetic treatment, a chronic pyelitis persists, as shown by urinary examination and renal and gastro-intestinal symptoms, pyelotomy or nephrotomy is indicated. Mechanical causes of obstruction are sought for and removed, and the pelvis is irrigated and drained through ureteral catheters.

Pyonephrosis.—When in the course of pyelitis the ureter becomes blocked, pyonephrosis develops. The same condition is produced by infection of hydronephrosis. The pelvis becomes rapidly distended, and ulceration and dilatation of the calyces occur (Fig. 339). When the condition is permanent the entire kidney is riddled with abscesses. The obstruction is usually incomplete; or the ureter may be completely blocked (closed pyonephrosis), so that there is no pus in the urine. Pyo-ureter is a not infrequent accompanying lesion.

The pelvis may rupture early; later rupture may take place through the cortex; in either case there results a perinephric abscess. Exceptionally pus may become inspissated, and extreme contraction of the kidney occur. Pyo-

nephrosis may give rise to general metastasis, but this is rare. Occasionally adhesions to neighboring organs are formed and rupture into them takes place.

Symptoms.—In cases which follow the blocking of a ureter the first symptom is usually pain, which may be colicky, and is made worse by pressure, particularly when it is applied from in front. Chill and fever commonly herald the occurrence of suppuration in a hydronephrotic sac. The quantity of urine bears some ratio to the retention; anuria may be produced by reflex inhibition, though this is usually due to defect or absence of the other kidney.

A tumor may form in the loin, tender on pressure, fluctuating in most cases, but sometimes doughy, and projecting into the abdominal cavity. The tumor is often not perceptible. Percussion in the flank gives a dull note, but the presence of the overlying colon generally suffices to make the note on abdominal percussion resonant; alternate emptying and filling of the colon with air or liquid may aid in establishing a diagnosis.

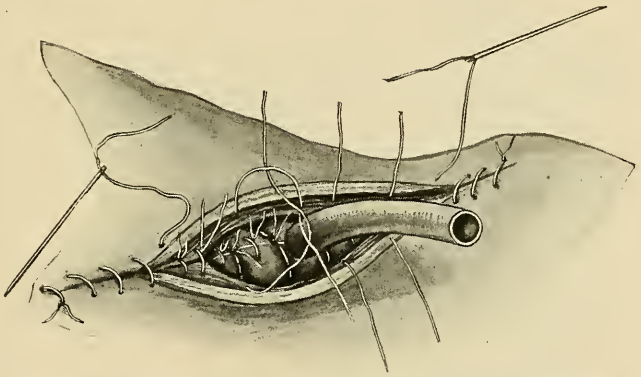


FIG. 340.—Operation of nephrotomy. The kidney-wound has been closed by deep and superficial interrupted sutures around the large rubber drainage-tube introduced into the renal pelvis. Lumbar muscles and skin being closed.

Pus may temporarily disappear from the urine (unilateral involvement and obstruction). A sudden reduction of pus in the urine does not imply obstruction unless it is coincident with a reduction in the quantity of urine. If the obstruction is permanent and the other kidney is able to compensate, the quantity of urine will gradually rise to the normal.

Irregular fever, with a high evening rise, chills, and the constitutional symptoms of internal suppuration are present in most cases, but some run their course with few or no general symptoms. Leucocytosis is present in at least the early stages of the disease.

Diagnosis.—The diagnosis of pyonephrosis is founded upon the presence of a tumor in the region of the kidney and on intermittent pyuria. The tumor cannot always be felt, since distention may take place upward towards the diaphragm. When perceptible it is rounded in form, obscurely fluctuating, and tender on pressure. A characteristic of the tumor is its variation in size, dependent upon temporary relief of obstruction and escape of the purulent urine contained in the kidney pelvis. This symptom is closely related to intermittent

pyuria; when but one kidney is affected, the other remaining healthy, there may be periods when the urine is absolutely normal, followed by periods during which there is marked polyuria, the urine containing a large quantity of pus; that with "closed" pyonephrosis the urine may be continuously clear has already been noted.

Rayer states that pyonephrosis must be distinguished from morbid enlargements of the spleen, liver, and gall-bladder, from renal tumors due to causes other than pyonephrosis, such as hydronephrosis, hemorrhage, tumor, tubercle, or cysts, from renal abscess, from tumors of the suprarenal capsule, from aortic aneurism, and from fæcal impaction.

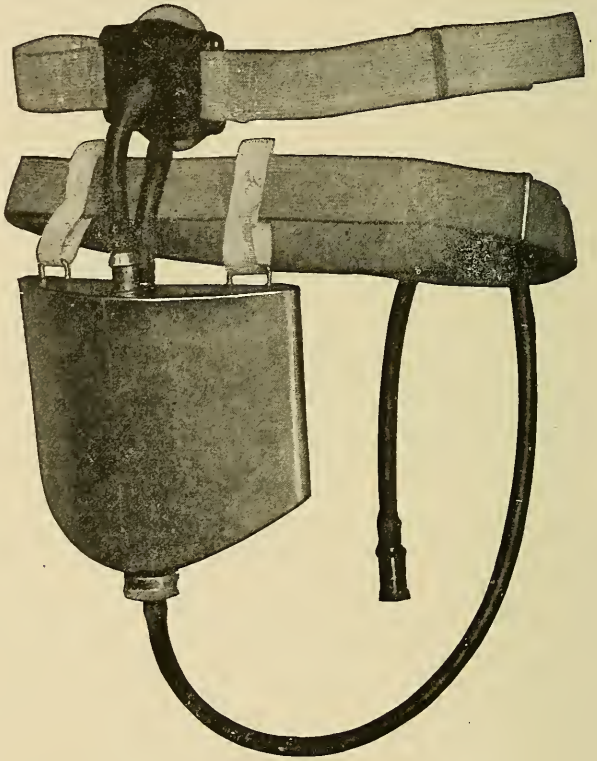


FIG. 341.—Watson's nephrostomy apparatus.

A differentiation from hydronephrosis or perinephric abscess is often difficult. Hydronephrosis is unattended by fever, and there is usually but slight pain; pyuria is absent. Perinephric abscess is characterized by severe pain, rapid extension of the tumor, marked constitutional symptoms, extreme local tenderness, and often œdema and superficial fluctuation. The urine may or may not contain pus; the thigh is often flexed upon the abdomen. At times a distinction cannot be made. This, however, is not a matter of great importance, since the three conditions, pyonephrosis, perinephric abscess, and hydronephrosis, practically require the same treatment.

Treatment.—Pyonephrosis, dependent as it necessarily is upon infection and obstruction, is amenable only to mechanical treatment. Ureteral catheterization will relieve tension, and hence stop septic absorption, and enable the surgeon to perform pelvic irrigation and instillation.

An obstruction which cannot be remedied by position or catheterization calls for operation, for immediate operation when septic symptoms are prominent.

Exceptionally the kidney atrophies, the pus which it contains becomes caseous, and there is thus effected a species of spontaneous cure.

The operative treatment may take the form of nephrotomy, nephrostomy, or nephrectomy.

The choice between the three procedures depends in part upon the condition of the kidney operated upon, and in part on the condition of its mate. Obviously it is not permissible to do a nephrectomy when the opposite kidney is not functionally competent to withstand the strain of a double burden; and

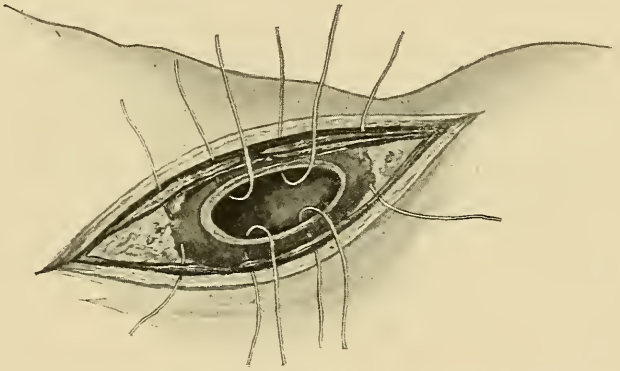


FIG. 342.—Operation of nephrostomy. First step: kidney anchored in lumbar wound by placement of two sutures near polar extremities of renal incision; cut edges of kidney sutured to lumbar muscles.

just as obviously it is the duty of the surgeon to ascertain as nearly as may be the condition of the opposite organ before exposing a pyonephrotic kidney.

When the ureteral obstruction can be removed, and the damage to the kidney structure is not irremediable, nephrotomy, with exploration of the pelvis for stone, evacuation of the contained pus, the removal of the obstruction, and the insertion of a tube drain (Fig. 340) is the operation of choice. When, because of the character of the obstruction or the extent of the damage already done, it is unreasonable to hope for a cure of the infection the kidney should be removed, provided its mate is in sufficiently good condition.

Nephrectomy may be performed either as a primary or as a secondary operation; statistics for the former are overwhelmingly in its favor.

Nephrostomy.—The object of this operation is to create a fistula of as large size as possible through the kidney-substance to the pelvis, best kept open by a silver tube. Some sort of receptacle must be worn to receive the urine, and for this purpose the one devised by Watson is the most convenient (Fig. 341).

The operation is performed by exposing the kidney through a loin incision

(freeing it as little as possible from its fatty capsule), and incising it either one centimetre back of Brödel's line or through the thinnest part of the parenchyma into the pelvis. The circumference of the kidney wound is then sewn to the fascia and a drainage-tube surrounded by gauze packing inserted into the pelvis (Figs. 342 and 343). If pus has escaped into the surrounding fascia, this region should be drained. When the operation is performed as a preliminary to cystectomy, the ureter should be ligated and divided.

Pyelonephritis.—This term signifies septic inflammation of the kidney secondary to pyelitis. It is the ascending form of renal suppuration; the descending form is best known as suppurative nephritis.

The predisposing and exciting causes of pyelonephritis are the same as those of pyelitis and pyonephrosis. It is merely a more extensive and more dangerous stage of pyelitis, and an almost unavoidable complication of pyonephrosis. The

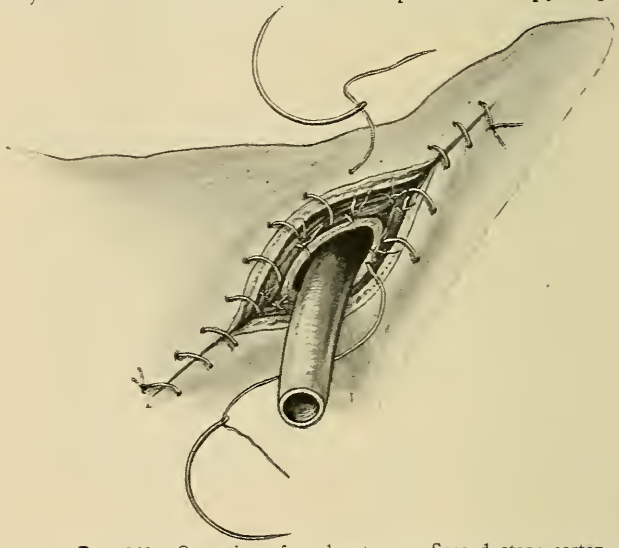


Fig. 343.—Operation of nephrostomy. Second step: cortex of kidney and lumbar muscles being sutured to the skin; drainage-tube in position.

infection extends from the calyces into the uriniferous tubules, involving the parenchyma of the kidney, and converting the organ into a mass of small abscesses (Fig. 344), or perhaps one large suppurating sac. The name "surgical kidney" has been applied to this form of suppurative disease, because it has been so frequently produced by the use of infected instruments.

Pyelonephritis is apt to develop rapidly when decomposing urine is retained in the pelvis; it may be caused by extension of inflammation in the absence of retention.

In the early stages of pyelonephritis the cortex of the kidney is thin, and the capsule is adherent to the surface and to the renal tissue. When it is stripped from the kidney numerous small abscesses are opened; the kidney is swollen, soft, and congested. Section shows yellows streaks, the distended straight tubules running from the cortex to the pyramids. Between these streaks

the renal substance seems to be healthy. The pelvis is congested, and exhibits patches of ecchymosis, or even of ulceration. Instead of small suppurating foci, large abscesses may form, and break through the kidney capsule.

Microscopically, the straight tubules are dilated, distorted, and filled with epithelial débris, pus, urinary salts, and microörganisms. The veins are also distended with partially coagulated blood and pus. (This is in marked contrast with pyæmic processes, in which the blood-clot and pus-formation take place within the arteries.) The Malpighian bodies and convoluted portions of the tubules become obliterated. The fatty capsule is infiltrated, tough, fibrous, and adherent in chronic inflammation, or it may become infected and suppurate.

The colon bacillus is the usual microbic cause of an ascending pyelonephritis.

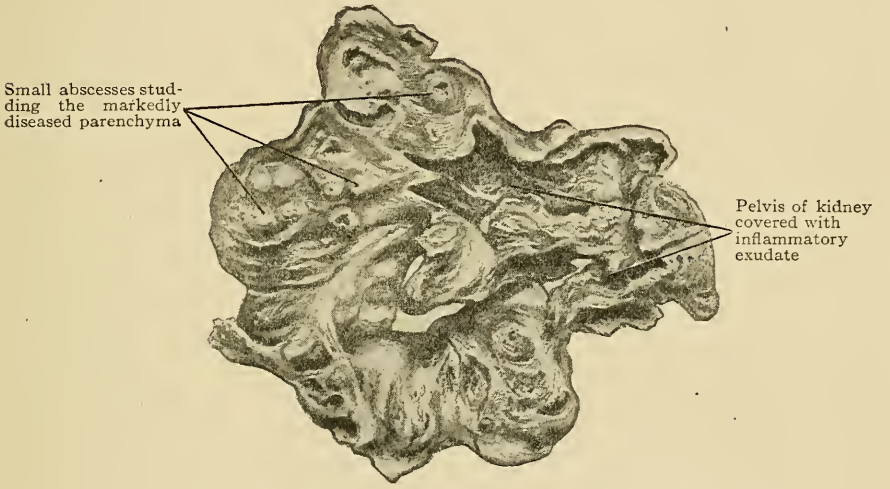


FIG. 344.—Pyelonephritis. (Laboratory of Surgical Pathology, University of Pennsylvania.)

Symptoms.—Pyelonephritis may assume the acute or the chronic form. The acute form is characterized by the suddenness of its onset, a chill, followed by high fever, and accompanied by severe pains in the loins being the usual sequence. There is often delirium, and the fever may rise to 106°, 107° F., or even higher.

Usually the fever is continuous, with remissions. The patient passes into a typhoid state; the tongue is dry and heavily coated; there is rapid emaciation, and often an extremely irritable condition of the stomach, and drenching sweats. There may be persistent vomiting and hiccough. Mental dulness, semi-consciousness deepening into coma, and finally death, follow.

The disease is usually rapidly fatal, terminating in about ten days or two weeks. It is obvious that symptoms of acute pyelonephritis are due in part to septic intoxication, in part to renal insufficiency.

All cases do not end fatally. The fever may gradually grow less, the stomach become retentive, and a return to comparative health follow. In such cases it seems probable that the pus has been so placed as to be well drained into the

ureter, or that it has become caseous and encysted, the secreting substance of the one kidney having been destroyed, and the remaining kidney having assumed double duty.

With the lessening or disappearance of fever the return to health is the exception, not the rule. The pyelonephritis is more likely to become chronic. In this form of inflammation the temperature may be normal. Commonly it is slightly and persistently elevated.

Rayer long ago pointed out that the chief symptoms of chronic pyelonephritis are often those of gastro-intestinal irritation: chronic dyspepsia, a dry brown tongue, secretion of saliva so scanty that solid food is refused, constipation, often tympany, sometimes uncontrollable diarrhœa. The patient is usually extremely weak and depressed, and sleeps badly. These symptoms gradually become more marked, and progressive emaciation, extreme susceptibility to local congestion from exposure to cold, and frequently intercurrent febrile attacks, develop. Locally there may be neither pain nor tumor, and the patient may be unaware of any urinary trouble.

Diagnosis.—This is based upon pus in the urine, pain, tenderness and at times tumor in the region of the kidney, the fever and the development of an otherwise inexplicable gastro-intestinal catarrh. In the absence of pyonephrosis, there are usually polyuria and constant pyuria. Oliguria is an ominous sign. The urine is alkaline. Microscopic examination shows hyaline casts and sometimes fragments of renal tissue. Exceptionally there is slight hæmaturia, rarely the bleeding is free; it is usually due to calculus. There may be absence of both spontaneous and provoked pain. There is frequent, often painful, urination, especially during acute exacerbations of the chronic inflammation. When pyelonephritis is complicated by pyonephrosis there is also the development of a swelling which may exhibit variations in size; if but one kidney is affected there may be intermittent polyuria and pyuria.

The differential diagnosis of chronic pyelonephritis from cystitis may be difficult. Cystitis, however, does not produce the constitutional symptoms, and ureter catheterization will show the absence of pus from the urine as it escapes from the kidneys. Cystitis and pyelonephritis are often associated. In such cases ureteral catheterization, by showing that pus comes from the kidney, is again serviceable; moreover, fever, rapid deterioration in health, and pronounced gastro-intestinal symptoms are characteristic of the kidney affection.

Tuberculous pyelonephritis, usually a mixed infection when renal symptoms become marked, may be characterized by the presence of tuberculous infection in other portions of the genito-urinary tract, the finding of the Koch bacillus, and the tuberculin test.

It is important to find out whether both kidneys are affected. This will be determined by the results of palpation and tests of renal function.

Treatment.—The preventive treatment of pyelonephritis is particularly important. In view of the fatality of this affection, it is impossible to express too emphatically the necessity for asepsis even in so trivial an operation as catheterization, especially when, as after chronic retention, the urinary tract is predisposed to infection.

When pyelonephritis has developed it should be treated as a combination

of uræmia and septicæmia. Liquid diet, particularly milk, the administration of diuretics and of diluents, counter-irritation over the kidneys,—in acute cases by dry cups followed by hot fomentations,—and the administration of laxatives, are indicated as the means of combating uræmia. Since septicæmia causes death by exhaustion, the administration of alcohol well diluted and of as much nourishment as can be assimilated is desirable. Quinine should be avoided, since it is useless in small doses, and in full doses markedly congests the kidneys. Small doses of salol are serviceable, since they tend to prevent ammoniacal fermentation in the kidney pelvis.

When pyonephrosis develops in the course of pyelonephritis, or, even in the absence of this, if symptoms are progressive, nephrotomy or nephrostomy with free drainage is indicated. The kidney should be opened into the pelvis on its convex border, and the examining finger should discover and break into every pus-collection of appreciable size. Theoretically nephrectomy is indicated, since the kidney is often riddled with multiple abscesses; the infection is, however, frequently bilateral. When after drainage the symptoms do not improve and there is a free discharge of pus through the lumbar wound, a secondary nephrectomy may be performed if examinations have shown that the other kidney is normal. The degenerated fatty capsule in chronic inflammations is often adherent to the kidney capsule proper, and to surrounding organs and structures, rendering enucleation of the kidney a difficult and dangerous procedure. Subcapsular nephrectomy should then be done.

Suppurative Nephritis, Acute Hæmatogenous Suppurative Nephritis.—Under this heading are classified renal suppurations in which the agents of infection enter the kidneys through its vessels, through its lymph-channels, or by contiguity. Such suppurations are seen in pyæmia, in endocarditis, and in the acute infectious fevers, as the result of extension of infection from adjacent tissues, or in consequence of traumatism or exposure to cold.

In hæmatogenous infections the condition is often unilateral, though embolic infection may simultaneously involve both kidneys. The abscesses are generally multiple; single large abscesses are occasionally seen. Hæmatogenous abscesses first form in the cortex; from these the entire gland generally becomes infected (Fig. 345). The abscesses may coalesce, and in some cases renal disintegration goes so far that nothing remains but a sac (the capsule) filled with pus. In non-hæmatogenous suppuration the process may commence in any part of the kidney, according to the origin of infection. The abscesses may rupture into the pelvis or through the capsule, with the production of perinephric suppuration. It is in suppurative nephritis that metastasis most often occurs.

When the kidney infection is simply an expression of a general pyæmia the suppuration is rarely extensive; small abscesses form about the glomeruli and the smaller vessels of the cortex of both kidneys, often with blocking of the uriniferous tubes. The renal substance is the seat of a parenchymatous inflammation. In rare cases of long duration, amyloid degeneration may occur.

Symptoms.—Acute hæmatogenous renal infection is often inaugurated by chill and high fever; sometimes patients complain of violent pains in the loin. This may be associated with tympany, tenderness and vomiting. Tenderness

is most marked at the costovertebral angle, and may be the only localizing symptom. Not infrequently a marked oliguria (or even anuria) occurs. Blood and hyaline casts may be present in the urine.

Fever of a hectic type develops in nearly all cases, and chills occur irregularly. Violent attacks of hiccough and vomiting are sometimes noted; these are probably uræmic. There are generally lumbar pains, severe prostration, and the rapid development of a typhoid state, the sensorium becoming clouded,

A B

FIG. 345.—Acute haematogenous suppurative nephritis. A, external appearance; B, view of mesial section. Note the cortical arrangement of the miliary abscesses. (No. 3861. Laboratory of Surgical Pathology, University of Pennsylvania.)

and the patient lying with symptoms of both pyæmia and uræmia. Typical uræmia with convulsions has been noted in a few cases.

The urinary changes are not constant. In some cases there are no alterations other than oliguria. A little blood and a few hyaline casts are often found on microscopic examination. Later in the disease granular casts give evidence of parenchymatous degeneration. Pyuria, especially if profuse, indicates that an abscess has been evacuated into the pelvis; this may be followed by marked amelioration in the general condition. In rare cases pieces of renal tissue may be voided.

Diagnosis.—Since enlargement of the kidney is usually slight, suppurative nephritis will not ordinarily be confused with extrarenal suppuration. The course of suppurative nephritis is too acute for neoplasms; hydronephrosis, pyonephrosis, and perinephric abscess generally occasion much more marked enlargement. Tympany, tenderness, and pain in the right lumbar region so often simulate acute appendicitis that an early differential diagnosis may be most difficult. The careful examination of the urine, the history and clinical course of the case, and exploration of the lower urinary tract will usually lead to the diagnosis. Renal suppuration, unless well drained, causes a circulatory leucocytosis.

Treatment.—This is at first expectant and symptomatic. The patient is kept absolutely at rest, and careful attention is paid to the constitutional condition. If the constitutional symptoms are those of profound and increasing sepsis, and the local symptoms are unilateral, an early nephrectomy may be performed. Partial nephrectomy has been performed successfully, but is more hazardous than the removal of the entire organ. It is often the case that symptoms pointing to the renal location of the infection are masked until the condition of the patient will not admit of an operation. Nephrotomy may be done in an effort to save an otherwise hopeless case. When suppurative nephritis develops in pyæmia it is a local expression of the general condition, to which treatment is mainly directed.

PERINEPHRITIS.—Perinephritis is, strictly speaking, an inflammation of the fibrous capsule; the term, as commonly used, implies inflammation of the fatty capsule. Inflammation of the true capsule occurs in nearly all renal diseases. It is frequently sclerotic, thickened, and adherent to the gland; it may suppurate secondarily to adjacent renal suppuration, or it may become involved in tuberculous and malignant processes.

Beyond the evidences of the renal or perirenal disease which causes it, perinephritis presents no symptom except pain. It seems clearly established that inflammation of the true kidney capsule causes more pain than involvement of the secreting portion of the kidney.

Inflammation of the fatty capsule of the kidney is common, since this tissue possesses a low degree of power of resistance to infection. It is not necessarily suppurative. After a long-lasting nephritis it sometimes happens that the capsule of the kidney is converted into a dense fibrous investment, the fat having almost entirely disappeared, or the fatty envelope of the organ may be greatly thickened, showing an increase of both adipose and fibrous tissue. This overgrowth is particularly abundant about the hilum, and much resembles in structure lipomata occurring in other portions of the body.

There are two forms of perinephric abscess: the primary, in which the suppuration arises *de novo* in the fatty capsule; and the secondary, in which the primary focus lies elsewhere.

The primary forms of perinephric abscess may arise in several ways. Traumatism is responsible for some cases. In injuries to the lumbar region when there is penetration, laceration, or cutaneous abrasion, pyogenic microörganisms have direct access to the tissues, and infection may follow; but there have been cases of perinephric suppuration following traumatism in which no super-

ficial injuries occurred. The rare instances in which such suppuration has followed severe jarring to the trunk or heavy lifting must be classed with the primary cases. Many cases have been attributed to colds. The infection may be explained in one of several ways: it may have been hæmatogenous, the traumatism or the cold having rendered the tissues susceptible to the circulatory microörganisms; or the traumatism may have excited to activity a latent disease. There may also be a perinephritis due to actinomycosis.

The secondary perinephric suppurations arise from many causes. From the kidney secondary infection is common. In any case of suppurative nephritis, pyelonephritis, pyonephrosis, pyelitis (especially associated with calculus), ureteritis, or tuberculous disease, a perinephric abscess may form. The infection may be due either to the rupture of an area of renal suppuration into the perinephric tissue, or to extension through the true capsule without discoverable opening. The infection may reach the fatty capsule from its periphery. Thus, appendicitis, parametritis and parovaritis, abscess of the spleen, gall-bladder, or liver, subphrenic abscess, psoas abscess, or any bone suppuration, and in rare cases abscess of the lung or pleura, may be the primary focus of suppuration.

In other cases infection may reach the fatty tissues by the blood- or lymph-channels. In pyæmia or internal suppuration, in puerperal fever, or after operations on the prostate, bladder, testicles, rectum, or ischiorectal spaces, such an infection may occur. Finally, there are rare instances of perinephric suppuration entirely without obvious cause, in which an infection by microorganisms from the colon may be possible. The condition is most common in middle-aged men, but has been noted in infants and in the aged. It is usually right-sided, exceptionally it is bilateral. The abscesses may be large or small, single or multiple. The latter condition is most often seen in cases where infection has proceeded from the kidney. The pus may spread from the fatty capsule and infiltrate the loose retroperitoneal tissue; in other cases it is walled in by a strong fibrous capsule. The perinephric lipomatous investment is more or less necrotic, and bleeding is not uncommon in the infected area. The pus is usually bland and odorless; it may, however, be fetid, or urinous. According to its origin the pus may contain renal tissue, concretions, parasites, or shreds of neoplasm. The kidney-substance often becomes secondarily involved, and amyloid degeneration may ensue. Metastasis to distant organs is rare.

The main portion of the abscess is usually placed directly behind the kidney, but the pus may burrow in various directions, and this tendency is of clinical importance. It may descend into the pelvis behind the peritoneum, opening into the rectum, vagina, urethra, or bladder (in about four per cent. of recorded cases). It may pass down within the sheath of the psoas muscle and point below Poupart's ligament, may follow the iliac vessels and point in the femoral region, or may pass out through the sacro-sciatic foramen and point in the gluteal region. Rupture into the ureter or the kidney is possible. In a few cases the abscess has discharged into the colon (of six cases, four recovered), duodenum, or stomach; the liver may be secondarily infected. Rupture into the peritoneal cavity is rare, as the peritoneum becomes thick and fibrous as a result of inflammation. The upward pressure of an extensive perinephric abscess may be sufficient to cause distressing dyspnœa.

Perhaps the most frequent direction of pointing, with the exception of those abscesses which open in the lumbar region, is towards the pleural cavity. Senator long ago called attention to the existence of a serous pleurisy which often complicates perinephritis, even though the abscess has not directly involved the pleura. There is a triangular defect in the diaphragm just behind the upper portion of the kidney through which infection readily passes. After rupture through the diaphragm the pus may infiltrate the retropleural tissue, penetrate the pleural cavity, causing empyema, or rupture into the lung, giving rise to pulmonary abscess. In some cases profuse purulent expectoration or the symptoms of suppurative pleuritis first attract attention to the perinephric suppuration, though, unless it is remembered that perinephritis may be a causative factor, the etiology of the pulmonary abscess or the empyema may remain unsuspected. In Fisher's series of ninety-four cases the pleura was affected in twenty-four per cent., the lungs in twenty per cent., and the pericardium in six per cent.

Symptoms.—The cardinal symptoms of perinephritis are tumor, pain, tenderness, and fever. The local symptoms depend upon the formation of pus and the direction of its extension. In the cases which are secondary to inflammation of the appendix, the uterus or its adnexa, the gall-bladder, etc., the symptoms of perinephritis are masked by those of the original disease. This is also true of suppuration secondary to infection of the urogenital tract or which occurs in the course of a general pyæmia.

The symptoms are clearly marked in cases following traumatism or cold or in those of hæmatogenous origin unassociated with general pyæmia. Pain, chill, and fever are generally the early phenomena.

The pain is at first confined to the loin and aggravated by pressure; soon any motion of the trunk or leg of the affected side greatly increases it. The patient lies on his back, with a lateral curvature the concavity of which is towards the side involved; the thigh is adducted and flexed. At times severe pains may radiate into the genitalia, around the abdomen, or into the thigh; this is due to pressure upon the nerve trunks. Even in the feverless walking cases the muscles attempt to protect the inflamed region; the thigh is adducted, the body is bent forward, and the trunk is fixed, usually with a lumbar flexion towards the inflammatory focus; the patient limps. In a few cases partial anæsthesia and paresis have been noted. Since the third and fourth lumbar nerves supply the muscles which flex the thigh, this symptom of flexion is most prominent where the abscess lies directly over them,—that is, about the lower third of the kidney. In some cases the thigh is fixed in flexion; in other cases any motion except extension may be performed painlessly.

The fever may be high or moderate; it is usually markedly intermittent or even remittent, and often presents the distinct hectic type. Chills and profuse perspiration are common. The blood generally shows leucocytosis, except when the condition is tuberculous. The gastro-intestinal tract is deranged, there are anorexia, vomiting, sometimes tympany, and these disturbances may be much aggravated by the pressure of the abscess upon the colon, with the production of obstruction and consequent stercoræmia.

The local symptoms develop early. There is a tender tumor in the loin, which may be indistinctly fluctuating and irregular in outline. The abscess lies

under the colon, and therefore usually does not produce an area of dulness on anterior percussion, but flatness is marked in the lumbar region.

The loin is usually swollen; this swelling may be slight or so distinct that the lumbar region protrudes. This tumor does not move with respiration. When external pointing is about to take place, the skin over the loin becomes red and waxy, and distinct œdema develops; the abscess usually opens in or near Petit's triangle.

Supradiaphragmatic symptoms often develop. Independent of perforation into the pleura, severe pleurisy may occur, presenting the recognized symptoms of that condition. In nearly all cases there is restricted abdominal breathing, and hence some dyspnœa. Apart from diaphragmatic rigidity, extreme dyspnœa may be produced by direct pressure of a large abscess.

In the acute cases the general strength of the patient is quickly and markedly reduced, prostration is extreme, and, unless there is natural or artificial evacuation, the patient becomes profoundly septic, or even may succumb to a general pyæmia. The tuberculous cases, however, and some of the infective cases, run a mild chronic course, in which the local phenomena largely predominate.

When the abscess forms visceral adhesions, or shows a tendency towards pointing externally, additional symptoms usually appear, though evacuation may be accomplished almost without symptoms. Opening into the loin is heralded by the well-known local signs of abscess-formation. Evacuation into the intestines is preceded and accompanied by colicky or continuous pains and a desire to defecate; when such symptoms arise, pus should be sought for in the evacuation. Symptoms of acute peritonitis may appear; these are usually reflex, or indicate intestinal implication rather than peritonitis. Rupture into the kidney or the ureter is accompanied by mild or severe renal colic, with frequent urination; the same pains, together with vesical irritability, may be present in case of rupture into the bladder, though this may take place without producing any symptoms. The downward and forward extension of the abscess is indicated by the increasing area of tenderness and the detection by palpation of inflammatory thickening of the tissues.

Rupture into the pleura is accompanied by severe cough, dyspnœa, and the physical signs of empyema; later there forms a lung abscess, or a pneumopyothorax; such an abscess may be evacuated through a bronchus.

In most cases immediately following rupture of the abscess there is marked amelioration of general symptoms, and the size of the tumor is decreased, but this may not be demonstrable. When fistulæ have formed they will discharge regularly and almost continuously, but not infrequently the tracts become blocked; this is followed by prompt exaggeration of both the general symptoms and the local signs.

Diagnosis.—Both noninflammatory and inflammatory conditions may be confounded with perinephritic abscess in its early stages. Among the former are lumbago and renal colic. In neither of these is there fever nor tumor. In lumbago pressure is distinctly comforting, and there is never radiation of pain to the genitalia; frequently the condition is bilateral. Pain similar to that of renal colic is exceptional before the abscess has reached sufficient size to give unmistakable signs of its true character by tumor formation and tenderness.

Of inflammatory conditions of other tissues which may be confounded with perinephritis, appendicitis, parametritis, and parovaritis are the most common, with abscess of the gall-bladder, liver, or spleen as rare causes of confusion.

The pain in appendicitis generally begins as an intestinal colic, and later radiates through the abdomen or towards the umbilicus rather than into the genitalia or down the thigh. The dulness in subacute and neglected cases is often in front of the colon, and more marked anteriorly than posteriorly, and the peritoneal symptoms are more pronounced. Moreover, the point of greatest tenderness does not coincide in the two affections. These elements of difference, with the history, will usually determine the diagnosis. Rectal exploration should also be made, and the urine should be carefully examined for pus.

Parametritis and parovaritis can generally be differentiated by the history and by vaginal and rectal examinations.

Visceral abscesses must be excluded by the history and by physical examination.

Coxitis and spinal tuberculosis may be closely simulated by perinephric abscess. The position of the leg may be the same as in coxitis, but the other joint-symptoms are not present. Spinal tuberculosis causes a marked rigidity of the vertebral column, with tenderness over certain points, pain on concussion, with relief of pain on extension of the spine, and angular deformity; these symptoms are absent in perinephric abscess. Moreover, there is no leucocytosis in bone tuberculosis unassociated with mixed infection.

Neoplasms of the kidney or adjacent tissues are sometimes very difficult to exclude, since the swelling of a perinephric abscess does not always fluctuate. The age of the patient might suggest the probability of renal neoplasm; fever and flexion of the leg would almost positively point to abscess. The examination of the urine sometimes furnishes evidence of perinephritis, though, unless the secreting substance or the pelvis of the kidney be inflamed, the examination will be negative. Rapidly growing sarcomata often cause a decided leucocytosis, while a mild leucocytosis may be present in cases of cancer; thus this sign of abscess may be misleading. In doubtful cases an exploratory puncture is justifiable, since a diagnosis can usually be made from the material aspirated.

Ovarian cysts can usually be excluded by vaginal and rectal examination and by the history.

Of the inflammatory conditions of the kidney which may be mistaken for perinephric abscess, pyonephrosis, pyelitis, and suppurative nephritis are the most frequent. The differential diagnosis is often very difficult, but, as the treatment of all is nearly the same, the difficulties are not embarrassing. The tumor of hydronephrosis or pyonephrosis resulting from a blocking of the ureter is of more sudden formation than an abscess; there is not the marked flexion of the thigh, the pain is more paroxysmal, and there is in hydronephrosis no fever. Pyelitis and suppurative nephritis do not occasion swelling, severe pain, or flexion of the thigh.

The knowledge of leucocytosis in the various renal inflammations has not yet been so formulated as to be of clinical service. Careful repeated examinations of the urine and the history of the case are the most important elements in differentiating perinephric abscesses from the renal infections.

Prognosis.—This is dependent upon the cause of the perinephritis. When the perinephric inflammation is secondary to infection of the kidney the prognosis must be guarded. When it follows contusion of the kidney the prognosis is extremely favorable if the condition is recognized and promptly treated.

The course of primary perinephritis is usually acute, the symptoms are severe, and the inflammation quickly terminates in death or evacuation of the abscess. In a few cases the abscess has become encysted, with complete recovery.

In case of pointing the subsequent history of the case depends upon the site of evacuation. Most favorable, of course, is lumbar or iliac evacuation, next is rupture into the colon, then rupture into the urinary tract, while the most unfavorable is rupture through the diaphragm. In the secondary cases the duration and prognosis are obviously influenced by the primary conditions.

Treatment.—When the diagnosis of perinephric abscess is fairly established there can be no reason for delay in surgical intervention. Palliative treatment is indicated only during the time the surgeon is determining whether or not pus is present in the perinephric region. Before the formation of a distinct tumor it may be quite impossible to distinguish perinephritis from any of the forms of kidney infection. During this period the treatment appropriate to suppurative renal disease is indicated.

When incision is practised, the opening should be in the lumbar region, and should be sufficiently large to allow of exploration of the kidney and its pelvis. It is best to use the finger instead of the knife to open up the abscess-cavity and break down septa. An admixture of urine with the pus indicates that there is an opening into the kidney pelvis, and suggests exploration of this cavity and of the ureter for the purpose of removing calculi or relieving obstruction. Frequently the pus has a fæcal odor, suggesting a communication with the bowel. This odor does not, however, indicate the formation of an intestinal fistula, but is due to the infecting organisms. When the abscess has burrowed widely its accessory cavities should be opened and drained; healing of these may be confidently expected after drainage of the centre of infection. In cases of long duration and where the abscess is of large size, the pressure may have caused marked atrophy of the kidney, or this organ may be so extensively infiltrated with pus that nephrectomy is indicated. In such cases it is safest to perform two operations, letting the patient recover from the constitutional effects of suppuration before submitting him to the shock and strain of a nephrectomy.

When the abscess has already opened, into a bronchus or the colon, for instance, it is possible that spontaneous cure may result. Surgical intervention may then be delayed, provided the patient's general condition is satisfactory and the quantity of pus discharged is diminishing. Should hectic temperature, emaciation, and loss of strength show deficient drainage, the centre of infection should be drained directly. The after-treatment of the incision made for drainage is important, since fistulæ are liable to persist, especially in cases of long-standing suppuration and in those complicated by pyelonephritis. Drainage should be thorough.

Actinomycosis.—Israel was the first to describe actinomycosis of the human kidney. Although the disease is very rare, he saw it both as a primary and

a secondary infection; the latter is the more common. Those following agricultural pursuits and leather industries are the ones afflicted with the actinomycosis. The diagnosis of involvement of the kidney, secondary to actinomycosis of the lung, pleura, etc., is largely inferential after the appearance of renal symptoms, and is not difficult. The symptoms of primary renal actinomycosis, according to Israel, are fever, pain and tenderness in the affected region, cough which may disappear, resistance in the hypochondriac region or a doubtfully palpable kidney, œdema of the lumbar region, and slight leucocytosis. The urine is normal. The fever is a combination of the remittent and intermittent types. The closest approximation to the correct diagnosis will likely be suppurative perinephritis. The precise diagnosis will in all probability be deferred until operation, when the discovery of pus containing the characteristic sulphur-like granules will furnish the clue and the microscope will demonstrate the ray-fungus.

The disease locates itself primarily in the cortex of the kidney, thus giving rise to an associated perinephritis.

Nephrectomy has resulted in cure, though with subsequent prolonged sinus formation. Active immunization with the ray-fungus should be employed after nephrectomy.

Pyelo-Paranephric Cyst.—A cystic tumor within the paranephric tissue connecting with a fistula of the renal pelvis has been described by Gallaudet. It may be due to a simultaneous rupture of the renal pelvis and the formation of a paranephric hæmatoma. The blood finally becoming absorbed leaves a connective-tissue capsule formed by perinephric tissue, the cavity of which communicates with the pelvis of the kidney. It may occur as the result of traumatism or of ulceration of the renal pelvis with urinary extravasation. Removal of the mass and closure of the fistula would constitute the treatment.

Renal Infarct.—The first indication of this in a patient with valvular cardiac disease may be sudden vomiting. There may be either retention, suppression or incontinence of urine, later followed by polyuria. Hæmaturia is rare, albuminuria develops rapidly, but is transient. The renal pain and tenderness are increased by lying on the sound side and the sensibility of the ilio-hypogastric nerve is exaggerated (Schmidt).

Phlebitis of the Renal and Perirenal Veins is a rare condition, which may arise as a result of pyæmia, or may be a beginning of nephric or perinephric abscess. It presents the symptoms, both constitutional and local, of severe acute inflammation in or about the kidney with extreme tenderness, rigidity, pain, œdema of the surrounding soft parts, chills, fever and sweats of a hectic type going on to the production of pronounced cachexia. The urinary symptoms may be negative, or, if abscesses have been formed, there may be pus and blood in the urine. Suppression may occur. The extreme rigidity and tenderness which call attention to the kidney may preclude palpation of the organ. The diagnosis is made largely by exclusion and upon exploration of the kidney. The few cases seen have been unilateral.

CHAPTER XXIX

RENAL TUBERCULOSIS AND FISTULÆ

Tuberculosis of the kidney may be one of the many lesions of a general miliary tuberculosis, or it may be a localized process, perhaps the single discoverable tuberculous lesion.

GENERAL TUBERCULOSIS AFFECTING THE KIDNEY

Renal lesions, as a part of a general miliary tuberculosis, are fairly common in the young. The multiple miliary deposits do not attain large dimensions, nor do they undergo the marked retrograde changes which are seen in the more chronic forms of the disease. Urinary symptoms are usually masked by those of the general infection, to the control of which treatment is to be directed.

LOCALIZED RENAL TUBERCULOSIS

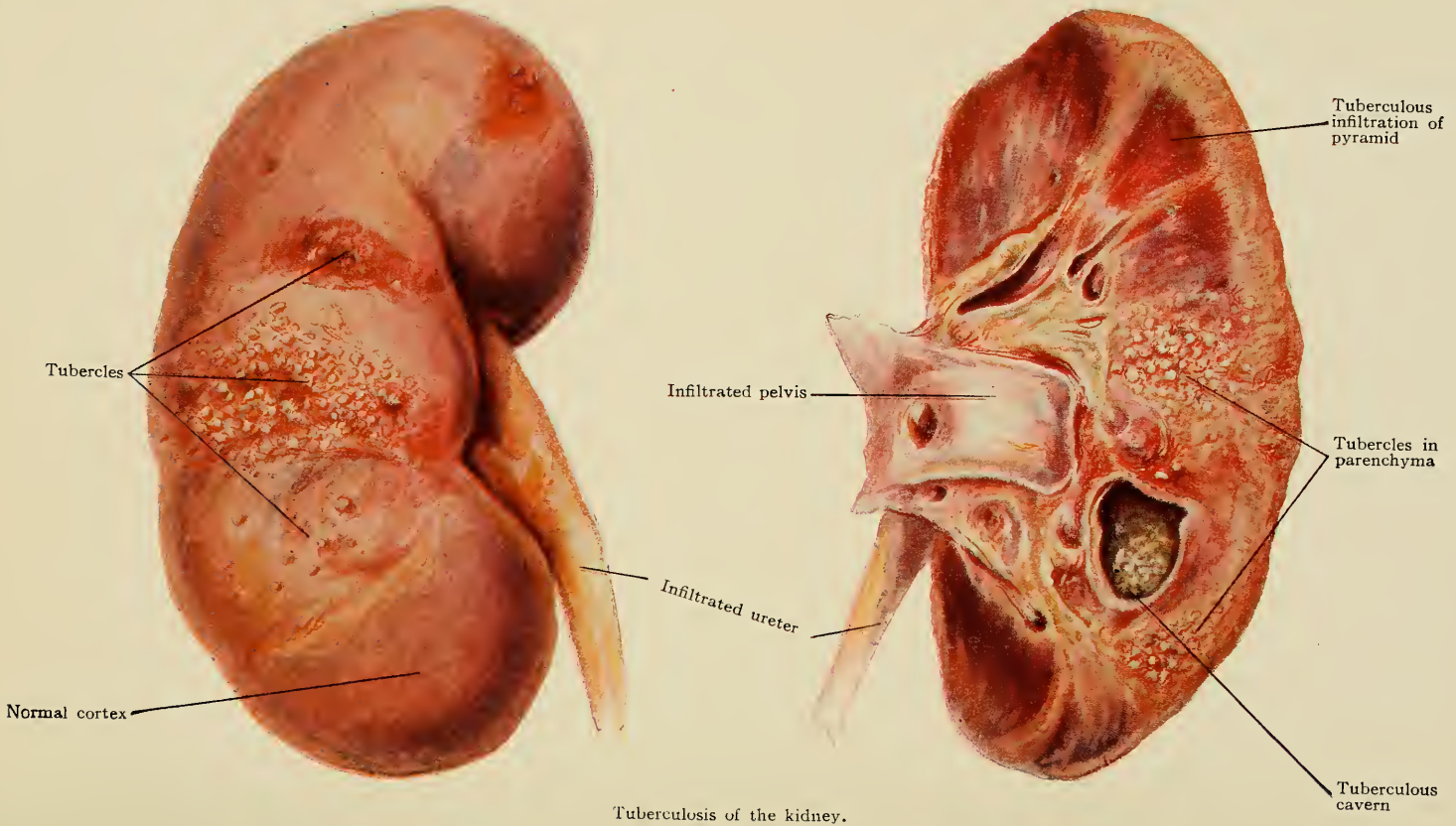
This may be acute or chronic, primary or secondary. The chronic secondary forms are those most commonly encountered, the acute stage having escaped notice.

In the primary infections the route is probably hæmatogenous. In the secondary infections the primary focus may be in any part of the body; in comparison to the total number of cases of tuberculosis the kidneys are not frequently involved. Infection carried by the blood to the kidney is the usual beginning of urogenital tuberculosis, which later involves the lower tract.

Taking all cases together, males are probably more frequently affected than are females, the proportion being about 2 to 1. Renal tuberculosis occurs most commonly between the ages of twenty and forty-five, though it is by no means confined to these limits; the extremes are three months and seventy years.

Pathology.—In the descending form of tuberculosis the condition in the beginning is usually unilateral, but later in the course of the disease the other kidney becomes infected (ascending infection from the bladder). In the ascending form the infection is usually bilateral. In hæmatogenous infection (descending) the tubercles are first formed about the glomeruli and the minute vessels, but these deposits may take place in any part of the gland. They gradually break down, and from them the infection is spread by the blood- and lymph-channels and by contiguity (Plate X). The mucous membrane of the calyces and pelvis becomes involved, either by distinct tuberculous formations or by diffuse infiltration. The breaking down of the aggregated tubercles leads to the formation of cavities—the so-called tuberculous cysts (Fig. 346). The contents are generally a yellowish-gray, sometimes blood-tinged fluid of thick consistency and urinous odor, compounded of pus, urine, blood, renal tissue, tuberculous matter, and detritus, with occasional collec-

PLATE X.



Tuberculosis of the kidney.

tions of lime salts, phosphates, and cholesterin. Tubercle bacilli can usually be demonstrated in the wall of the cysts, but they are rarely to be found in the contents.

Mixed infection is the rule in the advanced cases, and pus organisms are found in the cyst contents. The capsule of the kidney becomes sclerosed and thickened, and may present either a diffuse or a localized tuberculous infiltration; it is tightly adherent to the gland. The total bulk of the organ may be considerably enlarged by massive deposits and the capacity of the pelvis much reduced; or after extensive degeneration there may be marked reduction in the size of the organ, due to contraction of the connective tissue and

FIG. 346.—Advanced tuberculosis of the kidney. Typical exposition of the process of multiple cavity formation. (Laboratory of Surgical Pathology, University of Pennsylvania.)

the capsule. In the course of time the ureter is commonly affected, and its lumen may be so narrowed that the tuberculous kidney becomes pyonephrotic.

The perinephric tissue is always thickened, and may become tuberculous either by extension from the true capsule, lymphatic infection, or the bursting of one of the renal cysts. Thus perinephric abscess often complicates renal tuberculosis.

In cases of ascending tuberculosis, where a hydronephrosis often precedes the tuberculous infection, the process commences in the mucous membrane of the pelvis, attacks the apices of the pyramids, and gradually extends towards

the cortex, which it involves less profoundly than is the case in hæmatogenous infection. Obstruction, with the development of hydronephrosis and pyonephrosis, is commoner in the ascending form.

Bilateral tuberculosis in the majority of cases begins on the two sides at different times, there being sometimes an interval of years between the time of infection of the two organs. When but one kidney is infected the other is imperilled in two ways—the danger of tuberculous infection, and the danger of poisoning with the development of a nephritis as a result of the elimination of toxins generated in the already infected kidney. It has been repeatedly observed that the urine of the "good" kidney has improved after the removal of its infected fellow.

Symptoms.—There are usually no symptoms so long as the renal substance alone is affected, but pain develops when the mucous membrane of the calyces becomes involved or when an abscess empties into the pelvis; hence this is often the first symptom (Rosenstein). The pain is at first dull and aching, and is referred to the lumbar region. At times severe paroxysms occur (renal colic), and the pain is reflected to the penis and testicles. Pain may be increased by motion and position. Some patients acquire a habit of lateral curvature, with the concavity towards the affected side, since this position lessens their suffering. Urination may occasion severe pain, referred to the vesical neck; this is to be interpreted as a sign of vesical involvement.

Urinary symptoms may occur early; later they are constant. Undue frequency of urination and slight urgency or incontinence are symptoms which, in the absence of obvious cause, should always arouse suspicion of tuberculosis. According to Kelly, these are the first symptoms in about 70 per cent. of cases, but Rovsing states that in his series 60 per cent. of his patients consulted physicians on account of pain in the region of the kidney, emaciation, weariness, or turbidity of the urine long before the bladder symptoms set in. Later in the disease the fearful strangury and tenesmus of tuberculous cystitis are almost unmistakable.

Early in the disease the quantity of urine may be normal, but is often increased, constituting polyuria. As soon as the mucous membrane becomes affected, pus and blood appear in the urine.

Hæmaturia is usually slight and intermittent; it may be constant, but there is much less blood than in malignant disease or calculous pyelitis. The appearance of a few red blood-cells in the urine of a patient complaining of lumbar pain and frequency is highly suggestive of tuberculosis. After the abscesses have once opened into the pelvis pyuria is constant, except when the ureter becomes blocked; this complication is of frequent occurrence, but the obstruction is rarely permanent. In a few hours or days the blocking material becomes dislodged, and there follows a profuse gush of urine, loaded with pus and detritus. At times the tuberculous matter in the urine may be so bulky that it is with difficulty voided.

In those cases in which the ureter is permanently occluded a closed pyonephrosis of tuberculous origin results. If this occurs early in the disease, the resultant tumor is large; if late, after destruction of much renal tissue has occurred and a certain amount of scar tissue has been formed, the tumor is apt

to be smaller than the normal kidney. Calcareous deposits may form in caseous tuberculous material sufficiently dense to throw skiagraphic shadows (Fig. 347), which may be mistaken for those of calculi.

Albuminuria is present both because of the blood and pus in the urine, and on account of the nephritis which is set up. The albuminuria may be an early feature. A sterile renal pyuria is indicative of renal tuberculosis,

FIG. 347.—Tuberculosis of the kidney. A calcareous deposit in the caseated area casts a shadow in the radiogram, readily mistaken for calculus. (Skiagram taken by Dr. H. K. Pancoast.)

while a renal pyuria containing the pyogenic bacteria points to a pyelitis, etc., which may or may not have a tuberculous element. The urine is usually acid in the absence of pyonephrosis or bladder infection; after the advent of cystitis or when there is retention in the kidney pelvis, with mixed infection, it is alkaline. It is turbid according to the amount of pus it contains, and colored according to the amount of blood.

Microscopically, pus and blood are frequently found, but clots are rare. Hyaline casts are commonly present. Colombino asserts that deformed leucocytes are particularly characteristic. Epithelial cells from the kidney and pelvis are constant in the urine of cases with advanced lesions; renal tissue is occasionally seen; connective tissue and elastic fibres are sometimes found, and are of great diagnostic value, as are the little clumps of meal-like detritus which look like conglomerated nuclei and resist all reagents.

Tubercle bacilli should be sought for in all cases; especial care must be taken that the urine is fresh and that the smegma bacillus is excluded.

Physical examination reveals symptoms of diagnostic value. In many cases a tumor is noted in the loin, due to actual renal enlargement, to perinephric abscess, or to a pyonephrosis. This tumor may be outlined by percussion posteriorly, and may be felt through the abdominal walls. It may feel smooth or nodular, may fluctuate, and is generally tender on pressure. The enlarged ureters are sometimes palpable. Should the left kidney be the one affected, the spleen may be pushed forward and the real trouble thus obscured. Cystoscopic examination will frequently show œdematous pouting of the ureteral eminence with hyperæmia or even erosions about its orifice on the side affected (see Chapter V).

The patient ultimately suffers from progressive anæmia and digestive disturbances, with emaciation and cachexia. Irregular fever may be present, and often assumes a hectic type. Other tuberculous lesions commonly develop.

Diagnosis.—The diagnosis of renal tuberculosis is founded upon—(1) the demonstration of the presence of tubercle bacilli, by microscopic examination or inoculation; (2) the cystoscopic appearance of the bladder, taken together with a decrease in functional activity, particularly as demonstrated by the indigocarmin test; (3) the presence of pain in the region of the kidney; (4) vesical irritability; (5) slight, transitory, apparently causeless hæmaturia; (6) pyuria developed apparently without sufficient cause, and persisting; (7) an otherwise inexplicable polyuria; (8) the tuberculin test; (9) the formation of a lumbar tumor; (10) the development of tuberculous lesions in other parts of the body, particularly in the genito-urinary tract; (11) a tuberculous family history; (12) the development of tuberculous cachexia.

The only single sign which is absolutely diagnostic is the finding of the tubercle bacilli; since these microörganisms cannot be differentiated from smegma bacilli by staining reaction, in collecting the urine care must be taken to avoid contamination from the surface of the glans or the foreskin.

The cystoscopic appearance of the bladder is sometimes distinctive, at others the reverse (see p. 49), and must therefore be taken in connection with other factors in forming an opinion.

The propriety of using the ureteral catheter in cases of tuberculosis has been disputed, on the ground that it is so possible to carry tubercle bacilli into the sound ureter, thus implanting the disease in the sound kidney. It seems improbable that a mistaken diagnosis would result if a fair amount of urine be allowed to flow through the catheter before the specimen is collected, and cases of infection of a sound kidney occurring in this manner have not been reported.

It is of the utmost importance to ascertain not only which is the more diseased kidney (this can usually be done by means of the indigocarmin test without the insertion of a catheter), but whether or not the opposite kidney is also tuberculous. The presence of albumin and casts in the urine of the remaining kidney is not a contra-indication to the performance of nephrectomy, nor is a reduction in its urea excretion, as these may be due to the influence of its tuberculous mate, and may clear up promptly after nephrectomy, but it is inadvisable to operate in the presence of a bilateral tuberculosis. When catheterization is impossible on account of the condition of the bladder-wall, ureteral strictures, or the pain occasioned, dependence must either be placed on the observation of indigocarmin (chromo-ureteroscopy), or both kidneys must be exposed and examined as advised by Rovsing.

The tuberculin test may merely indicate that there is a tuberculous lesion in the body, or by the focal reaction, the kidney becoming more tender and the existent symptoms more marked, the tuberculous condition of this organ may be clearly indicated. The test performed by the subcutaneous injection of Old Tuberculin is the only dependable one; the usual initial dose is 0.5 mg.; should no reaction follow this injection, doses of 1.25, 2.5, and 5 mg. may be given, at intervals of not less than three days. A rise of temperature of not less than one degree, together with focal symptoms, is interpreted as a positive reaction; should a questionable reaction occur it is better to repeat the same dose before giving a greater quantity.

The development of a lumbar tumor is of diagnostic value only when it is associated with other characteristic symptoms of renal tuberculosis. There are no peculiarities of the tuberculous enlargement which would enable the surgeon to suspect the nature of the growth from physical examination. When the tuberculous kidney becomes infected with pus microörganisms—and this takes place in nearly all cases—the symptoms are simply those of a pyelitis, pyelonephritis, or suppurative nephritis, the diagnosis as to the underlying tuberculous nature of the affection then resting upon the result of bacteriological examination.

Calculus, with or without pyonephrosis, pyogenic infections of the kidney, spinal caries with abscess formation, with or without sinuses, tuberculous infections of other parts of the body, and cystitis, must all be considered and ruled out by appropriate measures.

Prognosis.—Untreated, the ultimate prognosis of renal tuberculosis is bad. A few cases heal; a few progress so slowly that there may be a fair degree of health for ten to twenty years. Yet it is not proper to delay operation in the hope that the use of tuberculin will bring about a cure; this agency should be used only when the disease is bilateral.

The prognosis in unilateral tuberculosis is good in proportion to the promptness with which the diseased kidney is removed. When the tuberculous infection is confined to one kidney, recovery is prompt, complete, and lasting; even when the bladder is obviously involved, a radical cure may be expected in more than half the cases. Nor is a complicating pulmonary tuberculosis in itself a contra-indication to nephrectomy.

Treatment.—When both kidneys are affected hygienic measures and tuberculin therapy are indicated. If one kidney has been converted into a pus-sac, with practically no remaining renal function, the removal of this sac would seem indicated rather than drainage through an incision, since the latter procedure always results in the formation of a lasting and troublesome fistula.

In unilateral tuberculosis, nephrectomy should be performed, through an incision large enough for the free exposure of the kidney and its pedicle. In advanced cases it may be found that the capsule of a kidney which has become degenerated as the result of tuberculous pyelonephritis has contracted dense adhesions to surrounding structures, and that the loosening of these adhesions may be impossible without opening the peritoneum, tearing large vessels, or injuring neighboring organs. In such cases it is advisable to practise subcapsular nephrectomy.

The ureter should be ligated, cauterized, and anchored in the wound at some distance from the peritoneum. Ureterectomy is not advisable as a primary operation, as in the majority of cases spontaneous healing takes place. In a few cases, however, on account of the persistence of vesical disease or a lumbar fistula, a secondary ureterectomy becomes necessary.

RENAL FISTULÆ

Fistulæ may form spontaneously as a result of the rupture of abscesses secondary to pyonephrosis, pyelonephritis, or perinephritis, or may be caused by traumatism or surgical intervention. They may pass down to the kidney surface, to its glandular substance, or into its pelvis.

Fistulæ are named in accordance with their direction and points of opening as reno-cutaneous, reno-gastric, reno-intestinal, and reno-pulmonary.

Reno-cutaneous fistulæ usually open in the lumbar or the inguinal region; their course is fairly direct.

Reno-gastric fistulæ are extremely rare. Duplay and Reclus quote Marquezy as authority for the statement that there have been three instances in which kidney stones were expelled through the mouth.

Reno-intestinal fistulæ are comparatively frequent, particularly those opening into the colon.

The causes of fistulæ are imperfect drainage, the presence of a foreign body, as a calculus or a drainage-tube, continuous profuse suppuration, as in simple or tuberculous pyelonephritis, and the constant escape of urine, as in wounds of the pelvis or of the ureter. Operative fistulæ rarely develop except when infected tissues are involved in the incision, or the ureter is impermeable.

Symptoms.—The most obvious symptom of fistula is the presence of an ulcerating opening from which escapes either urine or pus. Because of the continuous discharge, there are usually marked erythema and dermatitis about the opening. When these fistulæ are of long standing, diverticula are formed, the walls become rigid, and the tract, though fairly direct, is sufficiently tortuous to prevent the easy introduction of a probe.

Reno-intestinal fistulæ are suggested by vomiting or purging of pus and urine. Reno-bronchial fistulæ are characterized by an initial profuse dis-

charge of pus, followed by symptoms much like those of a purulent pleurisy which has broken into a bronchus.

Prognosis.—In the absence of tuberculosis, the prognosis of renal fistulæ is favorable when they open on the surface; there is even a fair prospect of spontaneous cure. These fistulæ exhibit a tendency to contract slowly, thus rendering drainage insufficient. Exceptionally, especially in tuberculous cases, there is a discharge so profuse that in itself it is exhausting to the patient.

Treatment.—Preventive treatment of fistulæ lies in prompt intervention in cases of renal or perirenal suppuration. When a fistula has formed and persists in spite of proper treatment, free direct drainage is indicated, followed by gauze packing and an effort to make the wound heal from the bottom. Should the fistula discharge urine, treatment is first directed towards rendering the ureter permeable and of normal calibre. When this is accomplished, the kidney may be exposed and freed from its attachments, the walls of the renal tract excised, the wound closed by catgut suture, and the parietal tract treated in the same way.

If the ureter cannot be rendered pervious, or if the fistula comes from a hopelessly disorganized pyelonephritic kidney, nephrectomy is indicated, provided the other kidney is healthy.

CHAPTER XXX

HYDRONEPHROSIS (URONEPHROSIS)

This is a condition characterized by distention of the kidney pelvis with fluid, usually urine. Morris, however, has recorded a case in which the fluid was composed wholly of water and sodium chloride, without a trace of urea or any other characteristic of urine. This absence of urea was probably due to pressure-atrophy of the epithelium of the tubules; the fluid of a hydronephrosis commonly contains less than half the urea of normal urine. Hydronephrosis is associated with pressure-atrophy of the kidney and interstitial nephritis, the gland and its pelvis becoming converted into a fibrous, thick-walled sac, in which the fluid is contained. The cause of hydronephrosis is obstruction to the flow of urine through any portion of the urinary tract; this results in distention and paresis of the pelvic and ureteral muscles.

Hydronephrosis may be congenital or acquired, permanent or intermittent, unilateral or bilateral, partial or total. In permanent hydronephrosis the distention is continuous; in the intermittent form of the affection, often associated with movable kidney, there are periods during which the obstruction is relieved and the retained fluid escapes, usually into the bladder. Partial hydronephrosis is caused by blocking of one or more calyces; this may be due to stone or to cicatricial contraction. Total hydronephrosis results from obstruction of the pelvic orifice or of the tract below; stone is the common cause, though ureteral kinks, strictures, blood-clots, masses of coherent pus, fragments of tissue, surgical ligatures, or parasites may occasion obstruction.

Congenital hydronephrosis may be unilateral or bilateral. Among the causes are imperforate urethra (Fig. 348) or ureter. Malformation, folds or duplicatures of the mucous membrane at the vesical orifice, congenital tumors of the bladder, ureters, or neighboring organs, movable kidney, and obstruction by anomalous blood-vessels of the kidney, are occasional causes.

Congenital strictures usually entirely obliterate the ureters. There may be a narrowing at the uretero-pelvic junction, or even a valvular formation here. Later in life there is sometimes an obstruction at this point, caused by the inflamed mucous membrane, which Küster states slides downward from its attachment, thus creating a valve. The ureters sometimes leave the pelvis obliquely or at an angle unfavorable to free drainage. This conformation may be congenital or may be due to gradual dilatation of the pelvis. Or the ureter may leave the pelvis at a point higher than normal, thus encouraging retention of urine and distention.

If the disease is bilateral it is rapidly fatal. Hydronephrosis may be present at birth, or may appear subsequently because of congenital deformity. When the disease is congenital the dilatation usually attains proportionally a much greater size than when it is acquired. Even though the congenital obstruction is caused by an impervious ureter, the kidney does not atrophy,

since during intra-uterine life it secretes much more slowly than after birth, and consequently intra-renal pressure is not developed with sufficient rapidity to arrest secretion before the delicate pelvic and ureteral tissues have become relaxed and overstretched.

The treatment is the same as that of acquired hydronephrosis. When the hydronephrosis is due to stricture or to valve-formation, lumbar incision followed by an attempt to remove the obstruction, is in order. Should the ob-

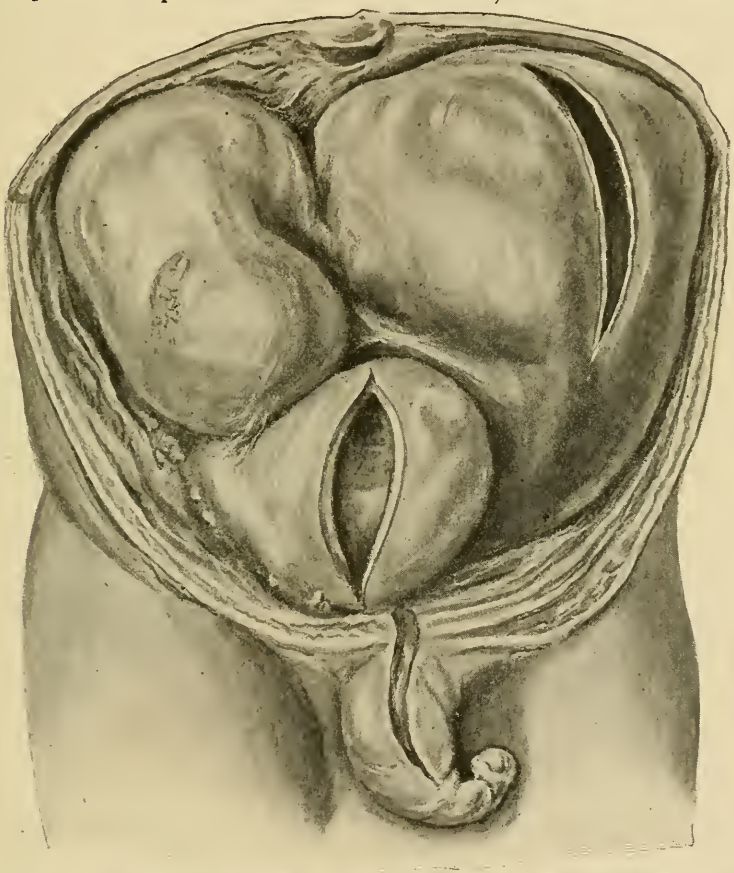


FIG. 348.—Congenital bilateral hydronephrosis. The greatly distended kidneys and bladder completely fill the abdominal cavity. The cause of the condition is a congenitally imperforate urethra. (No. 2012. Specimen in the Laboratory of Surgical Pathology, University of Pennsylvania.)

struction be irremediable, permanent drainage of the pelvis, or, if the disease is unilateral, nephrectomy, is indicated.

ACQUIRED HYDRONEPHROSIS is most frequent in women, probably because they are so commonly subject to pelvic disease and movable kidneys. It may be due to pelvic tumors, particularly those of a cancerous nature, displacements of the womb, pelvic inflammations, vesical neoplasms, traumatism, unnatural mobility, or ptosed position of the kidney, intra-ureteral blockage

by calculi, tumors, or pus, stricture of the urethra, enlarged prostate, and irritable bladder. This last condition is operative because the frequent act of micturition has a tendency constantly to close the vesico-ureteral outlets, producing backward pressure upon the pelvis of the kidney.

Of six hundred and sixty-five cases tabulated by Newman, stricture of the urethra and enlarged prostate and hypertrophy of the bladder were found to be the cause in one hundred and ninety-five bilateral and thirty-nine unilateral cases of hydronephrosis. Next in order of frequency came tumors of the pelvic organs, causing compression of the ureters. From this alone there were one hundred and forty-three bilateral and forty-one unilateral cases. Renal calculus produces unilateral hydronephrosis more often than any other of the causes noted, fifty-one cases being due to this alone; it was found to be the cause of only seventeen cases of bilateral dilatation.

In a certain number of cases observed at postmortem examinations no causes have been discovered. These may have been due to the acute angle of exit of the ureter from the pelvis or to undue irritability of the ureter.

Pathology.—The effect of hydronephrosis upon the kidney structure depends upon the completeness and the duration of the obstruction. Exceptionally the dilatation is confined solely to the pelvis. Usually the kidney is involved sooner or later, forming, with the pelvis, a rounded, irregularly nodulated tumor, varying greatly in size. Even in enormously dilated kidneys there are usually some remnants of secreting substance. As a rule, the walls of the cyst are made up of fibrous tissue. Such cysts have been known to contain several gallons.

Griffiths has carefully studied the histological changes produced by hydronephrosis. There are two distinct processes, one the result of pressure limited to the tissue pressed upon; the other a degeneration identical with that seen in chronic interstitial nephritis, due in part to the distention of the pelvis, which by compressing and stretching the renal vessels as they pass into the kidney interferes with the nutrition of the whole organ. Distention of the pelvis takes place mainly in a forward direction, pushing the renal vessels which lie in front, and thus stretching and flattening them. In the later stages of hydronephrosis there is thickening of the intima, and even of the media, with the formation of fibrous connective tissue, thus contributing to further diminution in the calibre of the channels which supply the kidneys with blood. Occasionally thrombi develop in these vessels. The cortical substance of the kidney is the slowest to disappear.

Finally the whole secreting substance is converted into connective tissue. The perinephric fat is infiltrated and adherent. The dilated larger excretory tubes persist for some time; at last even traces of these disappear, the hydronephrotic kidney forming a huge sac (Fig. 349), sometimes incrusted with urinary salts. The participation of the ureter depends upon the seat of obstruction. The contents of the hydronephrotic sac are water, with a diminished quantity of urinary salts and urea, and often a small amount of blood, desquamated epithelium, leucocytes, casts, and albumin. The solids are sometimes precipitated, forming a thick, semi-liquid, brownish mass. The sound kidney becomes hypertrophied. Symptoms are at times completely absent, and, pro-

vided the other kidney undergoes compensatory growth, there may be no interference with the general health.

Intermittent or relapsing hydronephrosis is characterized by an occasional partial or complete evacuation of the contents of the dilated kidney pelvis, followed by the passage of a large quantity of urine from the bladder. In one case, reported by Gintrac, the tumor was wont to subside suddenly by discharging into the colon, the subsidence being followed by copious watery stools.

The usual cause of intermittent hydronephrosis is movable kidney, the ureter being flexed or twisted, and remaining partially or completely impervious till a change in the position of the organ renders its duct patulous and the retained urine freely escapes.

FIG. 349.—Destruction of kidney from hydronephrosis. (Specimen in Philadelphia Hospital Museum.)

Occasionally intermittent hydronephrosis may be due to a calculus, which may act as a temporary ball-valve, closing the ureteral outlet from the kidney, but becoming dislodged when the pelvis is much dilated. After the subsidence of the tumor the patient may be free from symptoms for months, or even years, or the hydronephrosis may recur frequently.

Bland Sutton calls attention to the difficulty of deciding clinically between a very large hydronephrotic cyst and an ovarian or parovarian cyst, since cysts of the ovary and parovarium sometimes rupture, and the fluid escaping into the peritoneum is absorbed by this membrane and rapidly excreted by the kidneys, thus producing the characteristic symptoms of intermittent hydronephrosis—*i.e.*, tumor which suddenly disappears and is promptly followed by diuresis.

In nearly all cases of hydronephrosis the obstruction is not complete—that is, there is a partial escape of urine; hence, as a rule, there is intermittence in degree of tension. Clinically the term intermittent is applied only to those cases in which the swelling occasionally disappears completely.

Terrier and Boudoin collected eighty-three cases of intermittent hydronephrosis. They found movable kidney the usual cause, and called attention to the fact that the disease eventually becomes permanent, owing to inflammatory constrictions and adhesions fixing the displaced kidney.

SYMPTOMS.—Unless sufficient urine is retained to produce a distinct tumor, there may be no symptoms of hydronephrosis. The obstruction is usually of such a nature that retention is gradual and painless in its onset, and dilata-

tion of the kidney and its pelvis is not suspected until examination shows a smooth, rounded, movable, fluctuating tumor placed behind the colon and projecting into the abdominal cavity. The fluctuation can be detected only in large accumulations. Often there is a sense of weight and dragging, and sometimes there are distinct attacks of pain, resembling kidney colic, due to sudden increase of tension. Hydronephrosis develops without fever, in the absence of infection. The intermittent form of the disease is characterized by the appearance of a tumor of rapid growth, which gives rise to pain, and by sudden disappearance of the tumor, followed by polyuria. Pain which develops during the growth of the tumor may be extremely severe, and may present all the features of kidney colic. The intermission is sometimes as regular as are the recurrences of malarial paroxysms.

Diagnosis.—This is based on the detection of a fluctuating tumor primarily occupying the kidney region. When hydronephrosis is of such small dimensions that it cannot be felt by palpation, diagnosis is based on ureteral catheterization, injection, and pyelography.

Large hydronephrotic sacs are readily confounded with ovarian cysts, especially when the evolution of the tumor and its position while still small are unknown. It can readily be seen that a sac containing thirty gallons, as in a case reported by Bland Sutton, practically fills the abdominal space. Differential diagnosis may be impossible, and it has frequently happened that diagnosis has been made only after incision for operation.

By means of the cystoscope, with and without the addition of the X-ray, much valuable information is obtainable. When possible, the catheter should be passed into the pelvis, its entrance being evidenced by a more rapid flow; in a few cases, generally large tumors, it is impossible to reach the pelvis with the catheter. If the pelvis is entered, the contained fluid should be drained off and measured, and if any doubt remains as to the condition Kelly's suggestion of injecting the pelvis with a solution of methylene blue may be carried out, the ureteral orifice being watched to note any back-flow of the solution, the injection being continued till pain is occasioned; the fact that this pain is of the same character as that previously complained of is of great significance. In those cases in which there is still doubt as to the condition of the kidney, pyelography should be used. A pelvic capacity of more than 25 c.c. with blunting of the calyces is indicative of hydronephrosis (Figs. 350 and 351). A lessening of kidney function indicated by a delayed elimination of indigocarmin is often helpful in making a diagnosis.

Prognosis.—The prognosis of hydronephrosis is favorable if the disease is unilateral. Spontaneous cure may result, probably from atrophy of the secreting substance of the kidney. The more common terminations are pyonephrosis and pyelonephritis. When the disease is bilateral (Fig. 352) the prognosis is grave.

Treatment.—The essential thing in the treatment of hydronephrosis is the removal of the obstruction to the outflow of urine; when this cannot be done, a vicarious outlet must be established or nephrectomy performed.

Massage and manipulation of the swelling have been successful in overcoming the obstruction when it was caused by impacted calculus or kinks

FIG. 350.—Hydronephrosis, illustrating mild grade of the condition. Capacity of pelvis was 30 c.c. (Skiagram by Dr. H. K. Pancoast.)

FIG. 351.—Huge hydronephrosis. Its position, outline, and approximate size clearly demonstrated by colloidal silver. Note sharp bend in ureter indicated by arrows over spine. At operation found to be infected. (Mayo's Clinics, W. B. Saunders Co.)

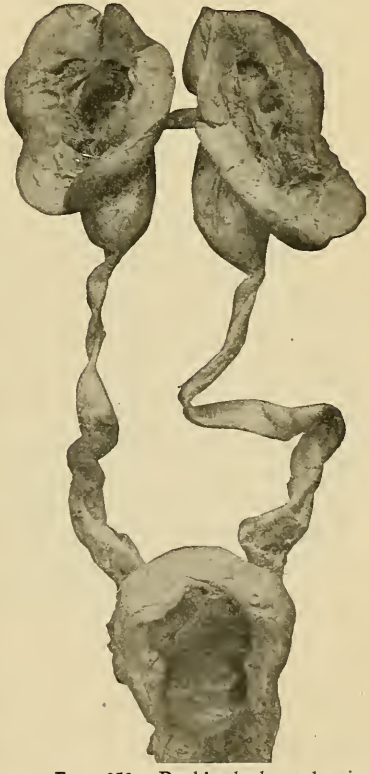


FIG. 352.—Double hydronephrosis secondary to concentric hypertrophy of bladder, this being secondary to hypertrophy of the prostate and calculus.

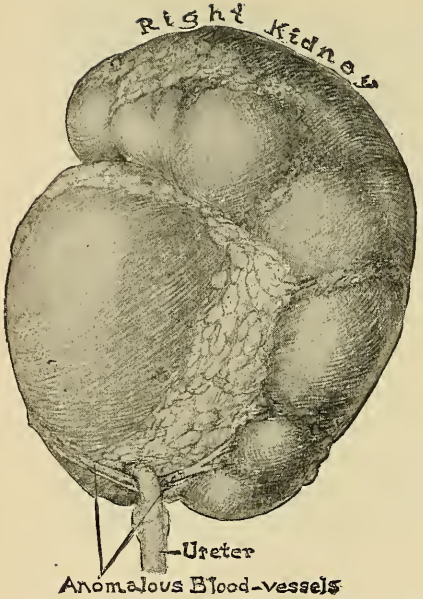


FIG. 353.—Hydronephrosis from kinked ureter, caused by anomalous blood-vessels. (Mayo's Clinics, W. B. Saunders Co.)

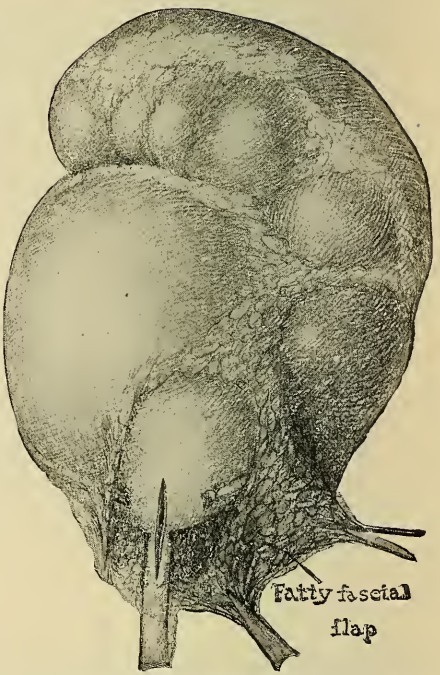


FIG. 354.—Blood-vessels cut and tied. Fatty fascial flap raised and ureteropelvic juncture divided. (Mayo's Clinics, W. B. Saunders Co.)

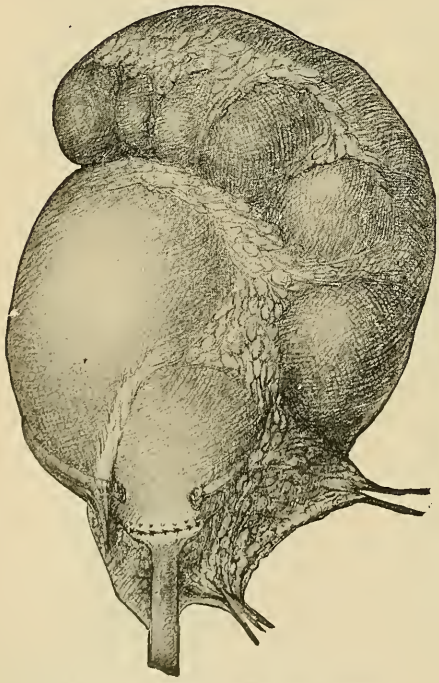


FIG. 355.—Plastic operation on uteropelvic juncture completed. (Mayo's Clinics W. B. Saunders Co.)

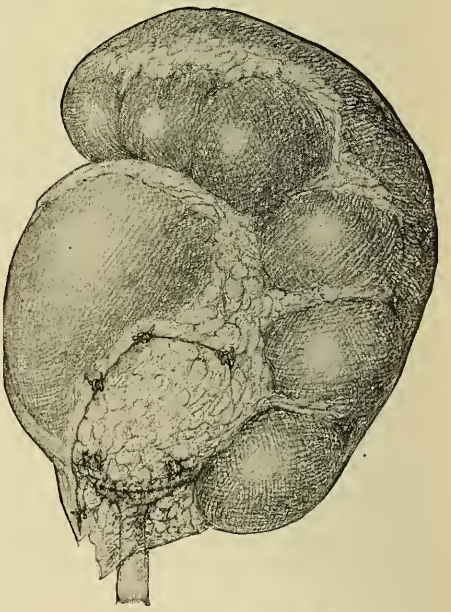


FIG. 356.—Fatty fascial flap in position, and held by a few catgut sutures. (Mayo's Clinics, W. B. Saunders Co.)

in the ureter produced by movable or floating kidney, a treatment not without danger, and usually affording but temporary relief. A properly fitting abdominal support may relieve the obstruction incident to movable kidney.

Ureteral catheterization is serviceable when retention is due to stricture of the ureter, to valve-formation, or to an anomalous exit of the ureter from the pelvis. It may not only relieve tension but may prove curative in case of stricture. In using the ureteral catheter the danger of converting a hydronephrosis into a pyonephrosis must be appreciated and guarded against.

Aspiration is a treatment which may be necessitated when the urgency of symptoms calls for temporary relief. There is usually a reaccumulation of fluid; in a certain number of cases after emptying the sac twice or thrice the secretion has ceased and the cure has been permanent. This is probably due to the fact that the secreting substance of the kidney has been completely atrophied. The operation is not free from risk of septic infection of the sac and the development of pyonephrosis. Morris advises, when no particular spot is suggested by discoloration or prominence, that the needle should be driven in, on the left side, an inch in front of the last intercostal space. "If there is no indication for operating elsewhere, the best spot to select when the kidney is on the right side is half-way between the last rib and the crest of the ilium, between two and two and a half inches behind the anterior superior spine of the ilium." The intestine is usually in front of the tumor and adherent to it, and may be wounded if the puncture is made too far forward.

Operative treatment will be required in the majority of cases. The kidney should usually be exposed through a lumbar incision (the transperitoneal route being used only for very large tumors), and examined to determine the cause of the condition, if this has not already been discovered through non-operative means. If the cause is removable, this is naturally the course to follow, so that the treatment is frequently that of pelvic or ureteral stone, or of movable kidney, or ligation and division of an anomalous vessel; or it may be necessary to do a plastic operation on the pelvis and ureter; or more than one of these procedures may be indicated. Some hesitancy must be felt in dividing anomalous renal vessels (Figs. 353, 354, 355, and 356), even though they be the cause of the obstruction, as infarcts of the kidney are apt to result.

When the obstruction cannot be removed, or there is a very large sac and disorganized kidney, nephrectomy should be performed, provided that the opposite kidney is functionally sufficient; otherwise nephrotomy or nephrostomy is indicated. Nephrotomy is followed by a persistent fistula in over fifty per cent. of cases.

CHAPTER XXXI

RENAL TUMORS AND PARASITES

PRIMARY tumors of the kidney are not common, less than one per cent. of malignant tumors taking origin here, while the percentage of benign neoplasms is probably even smaller. Classifications of renal growths are far from satisfactory; there is considerable variation in the terms whereby the same condition is described, and until comparatively recently there has been a misconception as to the nature of some of the commoner tumors, so that the older reports are valueless for purposes of statistical study. The following classification is suggested:

- **Embryonal**
  - Benign
    - Teratoma
    - Hypernephroma (but usually malignant)
  - Malignant
    - Hypernephroma (Grawitzian tumor, nephrogenic mesothelioma).
    - Mixed tumor (Wilms's tumor, embryoma of childhood).
    - Rhabdomyoma
- **Solid (Nonepithelial)**
  - Benign
    - Lipoma
    - Fibroma
    - Angioma
  - Malignant-Sarcoma
    - Round-cell
    - Spindle-cell
    - Fibro-sarcoma
    - Angio-sarcoma
    - Myxo-sarcoma
    - Chondro-sarcoma
    - Melano-sarcoma
- **Solid (Epithelial)**
  - Benign
    - Adenoma
    - Papilloma
  - Malignant
    - Carcinoma
    - Papillary cystadenoma (papilloadenocarcinoma).
- **Cystic**
  - Simple
    - Multiple retention
    - Single serous
  - Polycystic degeneration
  - Dermoid
  - Echinococcus (Hydatid)

The benign tumors of the kidney are of little importance from a surgical standpoint. They rarely reach large size, and seldom give rise to symptoms, being usually discovered at autopsy.

Malignant tumors, when primary, are unilateral; when secondary, they may be bilateral. They are found both in early childhood and in adult life,

after the thirty-fifth year, but seldom in the intermediary period. This is shown in the following tabulation of one hundred and sixty cases prepared by Kelynack:

Up to one year of age	12 cases
From one to two years	23 cases
From two to three years	16 cases
From three to four years	17 cases
From four to five years	6 cases
From five to nine years	10 cases
From nine to eighteen years	0 cases
From eighteen to twenty-five years	7 cases
From twenty-five to thirty-five years	8 cases
From thirty-five to forty-five years	17 cases
From forty-five to fifty-five years	22 cases
From fifty-five to seventy years	22 cases

Embryonal Tumors.—**Teratoma.**—These tumors, together with all benign tumors of the kidney, are rare. This group is due to an abnormality in the developing embryo whereby there is a displacement of parts normally found in other regions of the body. The tumors may reach considerable size.

Hypernephroma.—This tumor, when benign, is of small size and encapsulated. In the great majority of cases, however, hypernephromata are distinctly malignant, though they do not metastasize early.

Prior to the publication of Grawitz's article in 1883 these growths were not grouped together, but were considered to be lipomata (on account of their yellow mottled appearance), or sarcomata, or carcinomata. Grawitz advanced the theory that they developed from adrenal rests, a theory which received general support till recently, and to which their commonly accepted name is due. It seems probable, however, that this is a mistaken hypothesis, and that, as contended by Wilson, these tumors develop from nephrogenic tissue which has failed to form a connection with the renal pelvis and has lain dormant till adult life, when through some accident of trauma, infectious irritation, etc., it has been stimulated to active growth. Accordingly, mesothelioma or nephrogenic mesothelioma is a more descriptive term than hypernephroma.

The tumors vary enormously in size, being sometimes so small that they are indistinguishable with the naked eye, sometimes so large that they change the conformation of the abdomen. The smaller specimens have a grayish or yellowish appearance; the larger ones are usually mottled and of a yellowish hue, at least in some regions. The consistency is much softer than that of carcinomata. They originate in the cortex, usually near the lower pole.

A distinct capsule surrounds both the larger and smaller growths (Plate XI); in the later stages this may be broken through, with secondary involvement of other portions of the kidney cortex or of the perinephritic tissues. A characteristic of these mesotheliomata is the frequency with which they involve the veins, the tumor tissue growing out into the renal vein even beyond the hilum. Metastasis is probably always by the blood stream; the organs most often involved are the liver and bones. The cells of the tumors are polygonal in type, usually arranged about blood-vessels, sometimes form-

ing finger-like projections, sometimes filling up alveoli formed of connective tissue. There may be a distinct cordon-formation, such as is seen in the adrenal, or tubules may be present (Fig. 357).

Nephrogenic mesotheliomata make up about 75 per cent. of the renal tumors coming to the attention of the surgeon.

Mixed Tumors.—These tumors are usually found in children under five years of age. They are due to inclusions in the developing kidney of cells from the adjacent mesothelial plate destined to form the muscles and bony

FIG. 357.—Mesothelioma. (From the Laboratory of Surgical Pathology, University of Pennsylvania.)

structures of the body (Fig. 358). They are of rapid growth, usually symptomless save for the presence of the tumor (Fig. 359), and by the time they are seen by the surgeon are commonly undergoing sarcomatous degeneration. The tumors grow with great rapidity. Metastasis occurs late, and takes place through the blood vascular system.

Rhabdomyoma.—Tumors containing only voluntary muscle are occasionally encountered, but are extremely rare. Usually they are sarcomatous when seen. They have been found only in early childhood, before the third year.

NONEPITHELIAL SOLID TUMORS.—The benign tumors of this group are lipoma, fibroma, angioma, lymphangioma, osteoma, chondroma, and myxoma. The last four are very rare; none are seen frequently.

PLATE XI.

Mesothelioma.

Lipoma.—The great majority of the lipomata reported have been of small size, accidental inclusions of fatty tissue beneath the capsule of the kidney. Formerly a considerable number of tumors were reported as lipomata which were in reality mesotheliomata of the Grawitzian type. The true lipomata

FIG. 358.—Mixed tumor of childhood. (No. 629. Specimen in Department of Surgical Pathology, University of Pennsylvania.)

practically never reach sufficient size or cause sufficient symptoms to call for the attention of the surgeon.

Fibroma.—Tumors composed entirely of fibrous tissue have not been described, but occasional specimens have been noted wherein fibrous tissue made

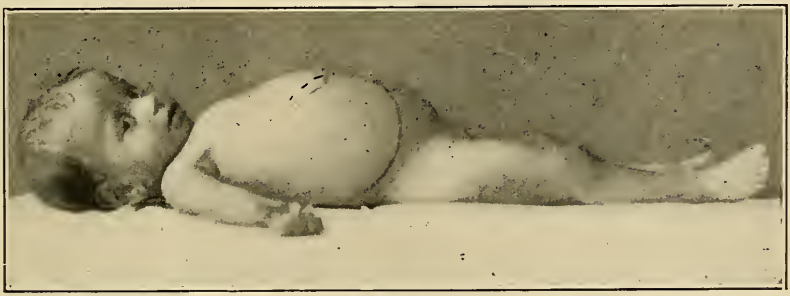


FIG. 359.—Mixed tumor of kidney showing abdominal distention; edges of liver and tumor mass indicated by lines in skin.

up the bulk of myo- or myxo-fibromata; however, these have never been of considerable size. Small collections of fibrous tissue are probably the source of origin of many of the true sarcomata of the kidney.

Angioma, papillary renal varix, or telangiectasis, differs from the preceding in the greater frequency of its occurrence and in the production of symptoms, sometimes of sufficient gravity to threaten the patient's life. While they are usually situated in one or all of the renal papillæ, causing them to appear greatly enlarged and engorged, they may also spring from the mucosa of the pelvis. The resultant hemorrhage may be so great as to demand nephrectomy.

Sarcoma.—Practically all the different varieties of sarcoma occur in the kidney. While by no means rare, sarcoma is not as common as the other malignant tumors, particularly the nephrogenic mesotheliomata and mixed tumors of childhood, the latter being generally considered as a distinct group, though they frequently exhibit sarcomatous degeneration. It is a tumor of the cortex of the kidney (Fig. 360), frequently originating in nodules of fibrous

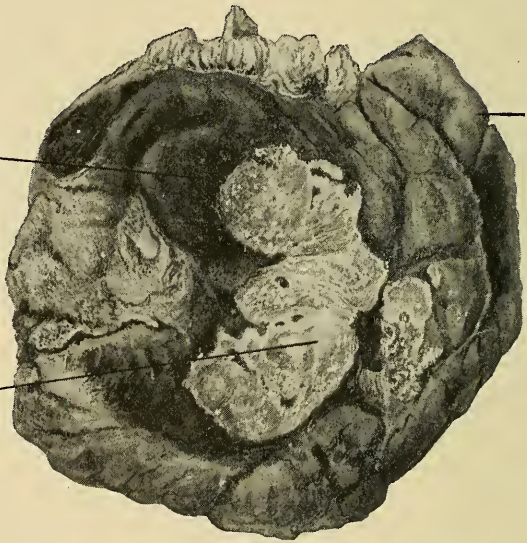


Fig. 360.—Sarcoma of kidney. (No. 2128. Specimen in Laboratory of Surgical Pathology, University of Pennsylvania.)

tissue; it is distinctly a tumor of adult life. Usually sarcomata are encapsulated. The degree of malignancy depends upon the histological elements present (Fig. 361), as in sarcomata elsewhere in the body; metastasis is by way of the blood-vessels.

Epithelial Solid Tumors.—Adenoma.—Small single or multiple adenomata are of rather frequent occurrence, particularly in the contracted kidney. They must be distinguished from embryonic inclusions and ectatic hyperplastic formations. They spring from the tubular epithelium; the cells are cuboidal or cylindrical, and the acini have a well-formed tunica propria. Alveolar, tubular, and capillary forms can be differentiated. Occasionally an adenoma may attain very large proportions. A special variety is the cystadenoma, which presents a papillary arrangement. Adenomata must be regarded as potentially

malignant, their chief importance lying in their tendency to undergo carcinomatous degeneration.

Papilloma.—This is the commonest tumor of the renal pelvis; it may spring either from the renal tissue or from the pelvic mucosa. The tumors may be single or multiple. The histological characteristics are those of papillomata of the mucous membranes of other parts of the body—numerous villi consisting of a central blood-vessel supported by loose connective tissue covered with several layers of cells.

Papillomata tend to undergo carcinomatous degeneration, and also give surface metastases to the ureter and bladder. They are usually symptomless till hemorrhage occurs from rupture of their blood-vessels, but pain may be produced by blockage of the ureter, or the ureteral orifice of the pelvis. Such an obstruction may cause hydronephrosis.

FIG. 361.—Photomicrograph of section from sarcoma of kidney shown in Fig. 360.

Carcinoma.—This develops from the tubular epithelium, or occasionally from the epithelium of the pelvis. In some cases the urinary canals may to a certain extent persist, and if dilated may form large spaces. The much-discussed intracellular formations of cancer-cells (coccidia) are well seen in these growths.

Cancer may be single or multiple, and may attain tremendous proportions. Two types may be distinguished: the nodular type, including growths which are adeno-carcinomatous (adenomatous at the beginning) and exhibit an alveolar arrangement, with cuboidal or cylindrical cells; and the infiltrating type, including growths which are cancerous from the beginning and show little alveolar structure; their cells are polymorphous (Fig. 362).

In the renal substance around the growth a compensatory hypertrophy may occur. More often there is a parenchymatous degeneration with interstitial overgrowth; at times amyloid degeneration. The central portions of the growth often soften and break down, forming cysts with sanguinolent contents; this breaking down is typical of carcinoma rather than mesothelioma.

The pelvis of the kidney may be involved (Fig. 363), then the walls of the ureter and perhaps of the blood-vessels, and later the adrenal and the fatty capsule; ultimately the infiltration may spread to the pancreas or the intestines.

Clinically, the neoplasm may be hard or soft, more often soft; it may become colloid and may form a fungoid vascular mass. It has been found associated with testicular carcinoma and (in the aged) with calculus. In a few cases the growth has broken through the skin. Metastasis occurs most frequently to the retroperitoneal lymph-glands, the lung, and the liver.

The tendency to produce hæmaturia is due to the infiltration of the tumors.

FIG. 362.—Carcinoma of the kidney. (From the Laboratory of Surgical Pathology, University of Pennsylvania.)

The earlier metastases occur through the lymphatics; later, when the veins have been invaded, carcinomatous thrombi may be carried by these vessels.

Contrary to the formerly accepted opinion, carcinoma of the kidney is rare before the fifth decade; the mistaking of mixed tumors for carcinomata is responsible for the large number of these growths formerly reported as occurring in extreme youth.

Papillary Cystadenoma, or Papilloadenocarcinoma.—This tumor occurs with about the same frequency as other forms of renal carcinoma. It is to be regarded as a malignant degeneration of the cystadenoma. The dif-

ferential diagnosis from other forms of carcinoma is possible only by the microscope (Fig. 364); the papillary formation, associated with tubular proliferation within cysts of variable size, is characteristic.

Symptoms of Benign Tumors.—With the exception of those tumors which involve the pelvis of the kidney, the majority of benign growths cause no symptoms and either escape recognition or are discovered accidentally. Occasionally the size of a benign tumor leads to its detection. Those tumors which affect the pelvis frequently cause more or less hæmaturia.

Symptoms of Malignant Tumors.—The three chief symptoms, in order of their observation by the patient, are pain, hæmaturia, and tumor. All three symptoms may be present in an individual case, or one or two of them

Fig. 363.—Carcinoma of the kidney. Growth is seen to infiltrate the pelvis. (From Laboratory of Surgical Pathology, University of Pennsylvania.)

may be absent, making the diagnosis more difficult. In a series of 83 cases operated upon in the Mayo Clinic and reported by Braasch, all three symptoms were present in 32 cases, two of the three in 37 cases, and but one symptom in 14 cases. Pain was complained of by 82 per cent. of the patients, and was the first symptom in 32 per cent.; hæmaturia, observed by 64 per cent. of the patients, was the first symptom in 47 per cent.; while tumor was the first evidence of disease in 15 per cent. of cases, was known to be present by 34 per cent. of the patients, and was found by clinical examination in 78 per cent.

Pain is very variable in its intensity and distribution. When due to distention of the renal capsule it is usually limited to the region of the kidney, but when due to pressure on the nerve-trunks and surrounding organs its

distribution may be very wide—throughout the abdomen, to both kidneys, to the back, as in gall-bladder disease, or to the genitalia.

To be of clinical value, hæmaturia must be so marked as to be detected by the unaided eye. It is usually an intermittent symptom. So much blood may be present that the clots are the cause of ureteral colic.

When a tumor is palpable it may be evidently a growth of the kidney, or it may appear as a mass of doubtful origin. The tumor is often adherent to the posterior abdominal wall, the small intestines are pushed to one side, and the colon lies upon the growth. As a rule, there is no movement upon respiration, though this is occasionally observed in cases of tumor of the right kidney. The feel of the tumor is hard, and may be smooth or nodular. Exceptionally there may be pulsation and a vascular murmur. If the colon

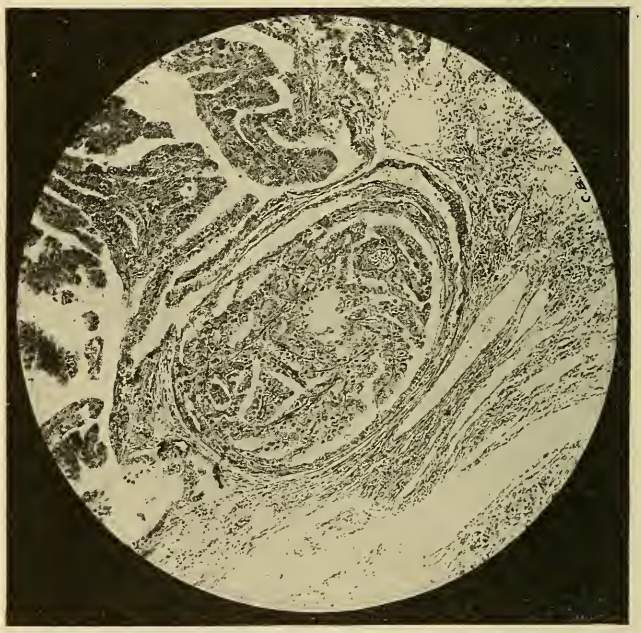


FIG. 364.—Papilloadenocarcinoma. Note the papillary formation and tubular proliferations within a cyst. (From a case of Dr. G. E. Shoemaker, The Journal of American Medical Association.)

is alternately filled with air and emptied, percussion will show that the tumor lies behind this segment of the intestine. The spleen is displaced by a tumor of the left kidney, and when the growth attains large dimensions various transpositions of the organs may be seen.

If one hand be laid upon the abdomen and the lumbar region gently tapped with the other hand, Guyon's sign may be elicited (*ballottement rénal*), a sign never produced by a normal kidney.

Pus may be found in the urine, but not in a sufficiently large percentage of cases to be of diagnostic value. Occasionally tumor tissue is separated from the main mass and escapes by way of the urethra.

Marked dilatation of the superficial blood-vessels has been noted frequently in patients suffering from hypernephroma (Braasch). The face, the scrotum

(varicocele), and the bladder are the most frequent places where this is observed. The development of a varicocele late in life suggests examination for a renal tumor.

There are gastric and intestinal symptoms (indigestion and constipation), with occasional diarrhœa. Ascites is often present in the late stages. Pressure upon the iliac veins or the inferior vena cava may cause a more or less pronounced œdema of the legs, while severe neuralgia with paresis may result from pressure upon the nerves. In late stages the inguinal nodes may become enlarged. The constitutional symptoms may remain long in abeyance.

Sooner or later the patient becomes anæmic, and a marked cachexia finally develops with mental derangement and an irregular fever, due probably to uræmia or auto-intoxication. Symptoms of metastasis may appear. In some cases a high pulse-rate is maintained. Kühn has pointed out that in children with congenital mixed tumors there is often a precocious development of the pubic and axillary hair and of the cutaneous pigment.

Diagnosis.—The diagnosis is founded upon pain, profuse intermittent renal hemorrhage, the development of a kidney tumor which is steadily progressive, the passage of fragments of neoplasm, the cystoscopic appearance, the result of functional renal tests, and pyelography.

In the early stages of tumor the diagnosis is obscure, and the condition may be confounded with renal tuberculosis and calculous pyelitis. When, however, the growth becomes palpable, the fact that it can be felt by lumbar palpation or can be so pushed forward by pressure from behind that abdominal palpation becomes much easier, is highly characteristic of renal tumor.

Cancer of the colon may closely simulate renal neoplasm; auscultatory percussion may aid in distinguishing between these two affections. Moreover, primary involvement of the colon is more commonly complicated by partial or complete intestinal obstruction and by the passage of blood-stained fæces without hæmaturia. Kidney neoplasm rarely infiltrates the colon. The lateral position of renal tumors and the lumbar bulge is in contrast to the central position of growths arising from retroperitoneal lymph-nodes.

Pancreatic cysts can scarcely be distinguished from renal enlargements. Minkowsky's method of colonic distention with liquid may prove serviceable in differentiating between the two affections. When the colon is filled with water the kidney tumor is thrust back into the lumbar region.

Tumors of the suprarenal capsule do not often reach great size. Differential diagnosis between these tumors and those of the kidney is impossible.

From large pelvic tumors renal growths may sometimes be distinguished by the fact that if the patient be placed in the Trendelenburg position there may be demonstrated a tympanitic area between the pelvis and the lower border of the kidney tumor.

The intermittent, profuse, apparently causeless bleeding of renal neoplasm is simulated only by suppurative nephritis, purpura, and hæmophilia. Other symptoms of these conditions will suggest their presence. Bleeding from renal calculus is usually excited by exercise or jarring, and is promptly and favorably influenced by rest; it is not often sufficiently pronounced to cause clots. Bleeding from a tuberculous kidney is usually slight, but may be severe.

The presence of tubercle bacilli is sometimes the only possible means of making a differential diagnosis.

The superficial veins of the bladder are sometimes so markedly distended in patients with renal neoplasms, especially hypernephromata, as to suggest

FIG. 365.—Colloidal silver injection shows renal pelvis to be constricted, its calyces either irregularly distended or elongated and narrowed. Diagnosis: mesothelioma. Confirmed at operation. (Mayo's Clinics, W. B. Saunders Co.)

the diagnosis. A reduction of the functional power of the kidney as indicated by one of the functional tests is often helpful in distinguishing between renal and pararenal growths.

In cases in which the diagnosis cannot otherwise be established, pyelography should be used. The distortion of the pelvis by a renal tumor is often quite characteristic. "Spider-leg" retraction is most often seen, the narrowed calyces extending abnormally far into the substance of the kidney. Other frequent findings are narrowing of the pelvis (Fig. 365), irregular pelvic dilatation on account of tumor necrosis, and abnormal position of the pelvis—too near or too far from the median line of the body.

It is not possible to differentiate between the various malignant growths.

Prognosis.—Without operation the ultimate outcome of malignant disease of the kidney is inevitably fatal, the average length of life from the onset of symptoms being about three or four years; death results from hemorrhage, renal insufficiency, asthenia, or from metastases in vital organs.

The mortality of operation is from ten to fifteen per cent. The prospect of permanent cure after removal of the tumor depends largely upon the date at which operation is performed. Braasch found that those patients operated upon in the Mayo Clinic who were reported as well at the end of three years had had symptoms for an average period of 1.6 years when they applied for treatment, while of those who lived less than three years the duration of symptoms was 2.8 years.

Treatment.—For those cases which are seen before the disease has spread beyond the confines of the kidney, the only treatment to be considered is nephrectomy. In the presence of metastases, of a tumor firmly fixed to the surrounding structures, of marked ascites, or great emaciation, the disease being irremovable, the symptoms must be treated as they arise. However, when any hope whatever of complete removal exists, even with some risk to life, the patient should be given the advantage of operative treatment.

The incision must be free, running from the lumbar muscles just below the last rib to the middle of the rectus on the same side. The rib should be freed or resected and the kidney removed with the perinephric fat, if this be possible.

Cystic Tumors.—**Simple Cysts.**—These are of two kinds: small, usually multiple, retention cysts, and large serous cysts, usually single.

Retention Cysts.—These cysts, varying in diameter from a millimetre to a centimetre, are probably caused by blocking of the secreting tubules. They cause no symptoms, demand no treatment, and are of importance only through danger of their being mistaken for polycystic degeneration.

Serous Cysts.—Possibly of similar origin as the foregoing, possibly due to the development of embryonic rests, serous cysts arise usually from the lower pole of the kidney, more often in women than in men. Though usually of moderate size, occasionally they reach enormous proportions, Morris having reported one whose content weighed 16 pounds. The condition is rare.

When small they produce no symptoms and demand no treatment; when of large size they may cause pain by pressure. The larger tumors have been mistaken for ovarian cysts; a more frequent error is to mistake them for cases of hydronephrosis. Drainage of the cyst cavity after carbolization, resection of the cyst-wall, and nephrectomy are the methods of treatment which have been employed; when the opposite kidney is functionally sufficient the last method is the one to be preferred.

Polycystic Degeneration.—In this condition the kidney, almost invariably both kidneys, is converted into a mass of cysts (Fig. 366), with comparatively little unchanged renal tissue between the vesicles. The cysts are usually of small size, though occasionally one of the cysts may become larger than its fellows, even growing to the size of a grape-fruit. The etiology of the condition is not known, nor is it known whether the infantile and adult forms of the disease have the same derivation. The disease is most common during the first and after the fortieth year of life; it is almost unknown between the first and twenty-first years. It may develop during intra-uterine life, and be so far advanced at the time of birth as to cause dystocia.

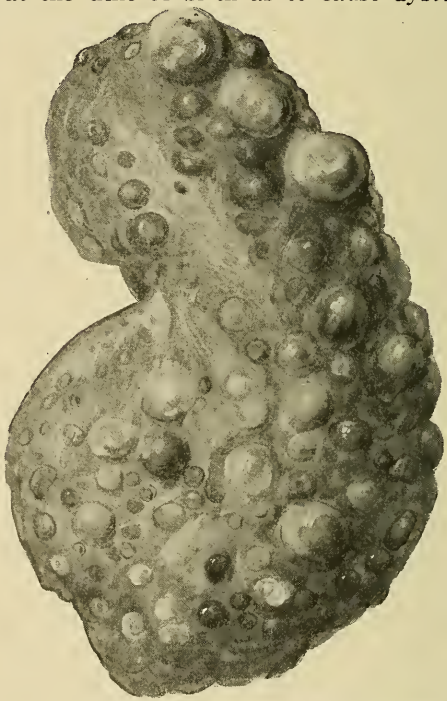


FIG. 366.—Polycystic degeneration of kidney. (No. 3363. Specimen in the Laboratory of Surgical Pathology, University of Pennsylvania.)

Symptoms.—Pain in the loin, due to distention of the renal capsule, or that of ureteral colic, due to the passage of clots of blood, hæmaturia, and the evidences of a failing renal function, together with the presence of a steadily growing tumor (or tumors, as the disease is bilateral in almost every case), are the signs of polycystic disease of the kidneys. In the infant, death usually occurs within a few months; in the adult, the onset of the disease may be insidious, and the course may extend over a number of years.

The diagnosis is made by the discovery of bilateral nodular renal tumors, there being no source from which metastatic tumors might have arisen, at a period of life at which these growths are commonly found. When doubt exists as to the character of the tumor, pyelography is usually a reliable means

of differentiation, the "spider-leg" appearance found in the case of solid tumor never being seen; instead, the calyces are apt to be obliterated, giving the pelvis an oval or squared contour, or, if the calyces be retracted, they appear as broad spaces.

Treatment.—On account of the almost uniformly bilateral character of the disease nephrectomy is rarely permissible, and both kidneys should always be exposed before one cyst-studded organ is removed. Occasionally pain can be relieved by the simple evacuation of cysts of large size. Otherwise treatment is entirely symptomatic.

Dermoid Cysts.—These extremely rare tumors are similar in character to dermoid cysts in other parts of the body. Diagnosis can only be made by section of the cyst. Nephrectomy is the treatment indicated.

Echinococcus cysts are considered under "Parasites of the Kidney" (see below).

Paranephric Tumors.—These may be cystic or solid; both are of rare occurrence. The cysts, unilateral and unilocular, are usually encapsulations of hæmatomata; most of the others are due to the development of embryonic rests. They are symptomless save for their bulk, which is sometimes great. The treatment is excision; this is easy in the case of the smaller cysts, but removal of the larger growths is sometimes a perilous procedure. With the exception of sarcomatous degenerations, pararenal cysts are benign.

Solid pararenal tumors spring from the fibrous and fatty perirenal structures. With the exception of sarcomata, which are occasionally seen, they grow slowly and are readily removed.

PARASITES OF THE KIDNEY

Echinococcus (Hydatid) Cysts.—The kidney is affected only in from five to eight per cent. of all cases of hydatid disease, and the process is generally confined to one kidney (usually the left). Any part of the gland may be affected, but the primary cyst forms in the cortex. The arrangement is that of the echinococcus hydatidosus. The cysts may become very large (eight inches in diameter), but are usually the size of an orange; they exhibit a tendency to protrude into the abdominal cavity, may contract adhesions to the abdominal walls and to the viscera, and may rupture into the pelvis, ureter, intestines, stomach, pleura, or bronchi, rarely into the peritoneum or through the lumbar muscles. Suppuration may occur spontaneously in the unruptured cyst or may be provoked by traumatism; septic absorption usually follows, and general pyæmia results. The contents of the cyst are slightly albuminous or mucoid and contain the hooklets. Hydatid cysts may coexist in other parts of the body.

Symptoms.—There is very little acute pain in connection with hydatid renal disease; there is often a sense of discomfort and of dragging; finally, pressure-pains develop, but not until the disease is over a year old. When, however, the cyst ruptures into the pelvis a ureteral colic is provoked, with very severe paroxysms of pain; the ureter may be plugged by tissue or by a daughter cyst, with temporary or permanent hydronephrosis. In a few cases a general urticaria has followed the evacuation of the cyst.

In the event of a rupture positive diagnosis may be made by urinalysis. After rupture the cyst may become infected and suppurate, with the production of a pyonephrosis. In a few cases direct symptoms have been excited by pressure upon veins. Frequent urination was the chief symptom in a case of Tait's.

The tumor is round, and may be tender on pressure; it may feel hard or may fluctuate distinctly; the hydatid thrill is rarely elicited in renal cysts. An eosinophilia may be present.

Diagnosis.—Hydatid cysts are ordinarily to be confused only with hydronephrosis or ovarian cysts.

Treatment.—Recovery after spontaneous evacuation is very rare. The only treatment to be considered is operative. The cyst is exposed, aspirated, and injected with a five per cent. formaldehyde solution, and a few minutes later dissected free from its fibrous investment. The resultant cavity is closed by suture. For a suppurating cyst, drainage is indicated.

Strongylus gigas, or "palisade worm," is a parasite of animals, the presence of which in the kidney of man is doubted.

Distoma hæmatobium is a parasite observed among the Fellahs and Copts. The worm lives in the portal vein and its branches. The eggs are found in the capillaries of the mucous membrane of the urinary tract. Diagnosis is based on finding the eggs or embryos.

Pentastoma denticulatum has been found on post-mortem examination in the kidney of man.

Spiroptera hominis and **Dactylius aculeatus** have been found by Rayer in the urine. (For detailed description of these parasites, see Leuckart, "Die thierische Parasiten.")

CHAPTER XXXII

SURGERY OF THE SUPRARENAL GLANDS

THE suprarenal glands are of interest to the genito-urinary surgeon for two reasons, first beause these organs seem to have some relationship to sexual development, and secondly because their enlargements are likely to be confused with renal growths.

Each gland consists of a medulla and cortex, the two being derived from entirely different fundaments, and having entirely different functions. The medulla, in part or wholly, is derived from the fundament of the sympathetic ganglia, and is a part of the so-called chromaffin system; it is undetermined whether the whole medulla is of sympathetic derivation, or whether a part arises from cortical cells. The chief or only function of the medulla seems to have to do with the maintenance of blood pressure. The suprarenal cortex is derived from the anterior portion of the Wolffian ridge from which the kidney and genital gland likewise spring. Our knowledge of its function is not complete, but it certainly concerns sexual development.

The suprarenals are somewhat flattened organs, lying above and to the inner side of the kidneys. Their enveloping capsules are less strong than those of the kidneys, so that there is a greater tendency for tumors of these organs to invade the surrounding tissues. Their blood supply comes in part direct from the aorta, in part by way of the renal artery, and in part by a branch of the phrenic. The lymph vessels empty into the receptaculum chyli. The organs are firmly secured in their positions, so that displacement is rare.

TUBERCULOSIS

This is probably the commonest affection of these glands, and is usually secondary to tuberculosis elsewhere in the body. It may be unilateral or bilateral, and may be accompanied by the bronzed skin of Addison's disease. In addition to this there are very marked wasting and distressing gastric disturbances, with hæmatemesis. The symptoms of a secondary anæmia are present. Slight tenderness may be elicited.

Tuberculosis has usually been considered a medical condition, but a few cases have been successfully operated upon.

ABSCESS

Traumatism, tuberculosis, septicæmia, or pyæmia may be responsible for this condition. The diagnosis is founded on the history of the case, the localizing signs in the epigastrium and lumbar region, and the symptoms of sepsis. Exploration with retroperitoneal incision of the abscess is the treatment indicated.

SUPRARENAL TUMORS

Neoplasms of the suprarenals have been observed so seldom that neither their symptomatology nor their histological characteristics are fully understood. The most comprehensive article on the subject is that of Glynn.[2] The tumors may be either benign or malignant, and may involve either the medulla or the cortex. Glynn gives the following classification:

Benign Tumors

A. Medullary tumors: Group 1.—Hyperplasia (Clinically accompanied by high blood-pressure).

Group 2.—Glioma, Ganglion neuroma.

B. Cortical tumors: Group 1.—Diffuse hyperplasia.

Group 2.—Adenomata (strumarenalis of Virchow).

Malignant Tumors

A. Medullary tumors: Group 1.—Gliosarcoma (very rare).

Group 2.—Sarcoma. Six cases have been reported, marked clinically by high blood-pressure.

B. Cortical tumors: Group 1.—Sarcoma, often lymphosarcoma. The tumor is common in male children, especially between two and three years of age. Metastasis is most often to the liver, lungs, ribs, and cranial bones. Exophthalmos from the last form of metastasis is sometimes seen.

Group 2.—Hypernephroma or mesothelioma. This has the following structure: "It is a growth whose general appearance recalls in a greater or less degree the adrenal cortex. It consists mainly of round, oval, or polyhedral—but never cylindrical—epithelial-like cells, usually varying considerably in shape and size; sometimes multinucleated giant-cells are present. Unless the anaplasia is great, the cells are separated into alveoli or columns by a varying amount of delicate connective-tissue stroma, or of thin-walled blood-vessels upon whose walls they directly abut (Fig. 367); they are sometimes arranged in a perivascular manner. The general arrangement of the cells, connective tissue, and vessels suggests more or less completely the zona fasciculata, and the growth is of a carcinomatous type. In other tumors, or even in other parts of the same tumor, the cells are more spindle-shaped, and the general appearance is that of a sarcoma of a mixed-celled or large round-celled type with many giant-cells. It may be very vascular."

Gastro-intestinal symptoms are usually prominent, as is loss of flesh and strength. Pain, felt at the site of the tumor, or across the abdomen, or in the shoulder, is complained of early. The tumor is felt first at the end of the seventh or eighth costal cartilage, rather higher than tumors of the kidneys; it may reach the size of two fists. However, the most interesting class of symptoms are observed in children. These were found by Glynn to be of two types. In the obese type, found in both sexes, there were no genital

[2] *Quarterly Journal of Medicine*, 1912, v, pp. 157–192.

symptoms save an overgrowth of hair, both on the pubis and on other parts of the body. In the second type there was a marked sexual precocity among the males, and an unusual muscular development. It was observed that hypernephromata are associated with sexual abnormalities almost invariably in children, usually in adult females before the menopause, but apparently never in adult females after the menopause, or in adult males. In general, the influence of an overacting adrenal cortex seemed to be to accentuate masculine char-

FIG. 367.—Hypernephroma of suprarenal gland. (From the Laboratory of Surgical Pathology, University of Pennsylvania.)

acteristics in males, and in females to cause the development of masculine qualities. The opposite tendency has been noted but rarely. Adrenal rests or bilateral hyperplasia of the adrenal glands are found in at least 15 per cent. of female, but only in 0.7 per cent. of male pseudohermaphrodites. Bronzing of the skin is a comparatively rare symptom, even when the disease is bilateral. Hæmaturia is very rare.

TREATMENT.—When discovered before the disease has formed metastases or invaded the surrounding structures, unilateral tumors may be excised. The

operation is often difficult on account of adhesions. As the kidney may have to be sacrificed, the function of the opposite organ should always be ascertained before operation.

SUPRARENAL CYSTS

These are of surgical interest because they occasionally reach sufficient size to demand removal. True glandular cysts are not only extremely rare, but seldom attain considerable size, hence are not of great clinical importance. Cysts of embryonal origin due to the intra-glandular inclusion of Wolffian débris also arouse scientific rather than clinical interest.

Cystic adenomata are somewhat more frequent than glandular cysts, but are of very small volume and diagnosed only post mortem.

Serous cysts, or cystic lymphangiomata, are commoner than the glandular cyst and attain considerable size. It is probable that some of these serous cysts become hemorrhagic.

Pseudo cysts may have for their origin hemorrhage and necrobiosis of either the normal or diseased suprarenal gland. Hemorrhages may be due to traumatism or may occur in the course of infectious diseases (leukæmia, diabetes, and nephritis) or intoxications. These cysts are always unilateral, hence do not give rise to the symptoms of Addison's disease. Symptoms are varying and the diagnosis almost impossible (Terrier and Lecéne).

The tumor grows very slowly (years) in the hypochondriac region, is thoraco-abdominal in its development, and becomes prominent beneath the costal margin to the right or left. Even after operation the origin of the cyst may be left in incertitude.

The treatment consists either in marsupialization or complete extirpation, depending upon the extent and closeness of adhesion.

CHAPTER XXXIII

SYPHILIS

Syphilis is a contagious, inoculable disease; it is also transmissible by heredity. The first lesion of the acquired form of syphilis is a chancre; this is followed by general lymphatic enlargement, by eruptions of the skin, usually superficial and symmetrical and associated with similar lesions of the mucous membranes; later by chronic inflammation and infiltration of the cellulo-vascular tissues, the bones, and the periosteum, and finally by the formation of small tumors called gummata, which may appear in any portion of the body, but which commonly develop in the connective tissue.

Etiology.—Syphilis is due to the presence in the system of the *Treponema pallidum* (*Spirochœta pallida*).[1] The languor, pain, and fever preceding the eruption are due to the toxines engendered by the germs which are not yet sufficiently numerous and generalized to produce more pronounced symptoms. The eruptions on the skin and mucous membranes are due to local lodgement and growth of the infection. The profound alteration in nutrition so often associated with the secondary eruption is a manifestation of the general infection.

Following the secondary stage of the disease there may be no further symptoms of syphilis, or, after a period of latency, gummata may develop. During this period of untreated latency or apparent cure, syphilis may be transmitted to offspring, showing the persistence of infection. Even a latent infection, however, absolutely protects against fresh inoculation. A person who has syphilis is immune against a fresh attack till entirely rid of his infection.

The majority of reinfections found in medical literature are cases of so-called relapsing chancre, in reality a tertiary lesion of syphilis.

Immunity against Syphilis.—As a rule, it is found impossible to inoculate the syphilitic virus:

1. Upon a person who has already suffered from the acquired form of the disease, because the infection persists.

2. Upon a person who has inherited syphilis (Profeta's immunity).

3. Upon a mother who has borne a syphilitic child without showing in her own person any of the lesions of acquired syphilis (Colles's immunity), because the mother is already infected.

Syphilitic Reinfection.—Although syphilitic reinfection is rare, it unquestionably occurs, more frequently of late than formerly, suggesting that a greater number of infected persons are cured by modern treatment. A reinfection can be regarded as proved only when a sore shown to be syphilitic by finding spirochætes, or a typical chancre followed by a secondary eruption, the blood giving a strong Wassermann reaction, the lesions being cured by spe-

[1] For further description of this organism, see Chapter XLIII.

cific treatment (or possibly healing spontaneously), recurs after a Wassermann-negative period of months or years, the characteristic amnesis being given.

The pseudo-chancre is a relapsing primary or secondary lesion or a gumma.

The Contagion of Syphilis.—The blood of a syphilitic during the secondary period and the secretions from syphilitic lesions are contagious; however, the number of organisms in the secretions of gummata is so small that the danger of transmission of the disease by this means is almost infinitely remote. The blood may carry contagion after all the visible lesions of syphilis have disappeared.

Even during the most active stages of the disease the normal secretions are usually not contagious; however, successful inoculations have been performed with semen and milk of syphilitics, and spirochætes have been found in the urine of syphilitic nephritis.

It is possible that in the passage of the serum of the blood through the glandular membranes and cells the contagious particles are strained out.

The semen almost certainly during an untreated secondary period, and exceptionally during the tertiary, infects the embryo, and, by this means, the organism of the mother.

After the primary and secondary stages of the disease, both the blood and the discharge from the lesions are practically innocuous, so far as the conveyance of syphilis is concerned. This condition is generally reached at the end of two years. After three years contagion is rare, except by seminal transmission, and, according to Hutchinson, there is no recorded instance of its having taken place after five years. Nevertheless, inflammatory lesions the result of syphilitic infection may appear for many years, and inoculation with the scrapings of unbroken gummata will cause the development of chancre in the orang-outang in more than half the experiments.

Whether contagion be derived from the discharge of a chancre, from that of a mucous patch, or from the blood of a syphilitic, the primary lesion at the seat of inoculation is a chancre. Except in the hereditary conceptional forms, a chancre is the starting-point of syphilis.

Filtering, heating for an hour to 51° C., or desiccation, renders the virus non-inoculable.

Methods of Contagion.—Syphilis differs from the other exanthemata in the slowness of its course, in the comparative mildness of its constitutional symptoms, and in requiring actual contact for its transmission. The method of infection is by inoculation or heredity.

The contagion may be either immediate or mediate.

Immediate contagion—that is, contagion direct from one individual to another—usually takes place during sexual approach, though it may occur from unnatural practices, from kissing, from wounds inflicted by the teeth of syphilitics, or, in the case of medical men, from operating on syphilitic patients, when the hands of the operator are wounded or abraded.

Inoculation is more readily accomplished through a superficial abrasion than through a deep wound.

Mediate Contagion.—In this form of contagion the disease is conveyed not by direct surface contact, but by means of spoons, glasses, pipes, clothing, etc., upon which the specific virus is deposited by a person suffering from some of the lesions of syphilis, and from which it is inoculated in some surface break of a person not immune to the disease. The list of articles which have thus conveyed syphilis is comprehensive. Among the frequent carriers of contagion are pipes, cigars, razors, pencils and penholders, surgical and dental instruments, towels, handkerchiefs, articles of clothing, and human vaccination lymph. Many unusual methods of contagion have been observed. Melot reports a nasal chancre developing in a pedestrian who was accidentally hit by the whip-lash of a passing teamster. The latter, who was syphilitic, had formed the habit of biting his lash.

Types of Syphilis.—Syphilis may begin and end with chancre and inguinal adenitis, no other symptoms developing. After such a sore and the entire absence of secondaries unmistakable tertiary lesions may appear years later. It seems reasonable to conclude that infection may exceptionally be so mild that by systemic resistance it may remain permanently latent or be radically cured in its primary stage.

The disease may have for its manifestations a chancre, general adenitis, and one light outbreak of macular or papular eruption involving the skin and the mucous surfaces of the mouth and throat, thereafter showing no signs.

More commonly following the chancre there is a single exanthematous outbreak, disappearing promptly under treatment, but recurring occasionally, particularly in the mouth and throat. These recurrences yield promptly to vigorous antisyphilitic treatment, and are not followed by tertiaries. The types of disease thus described are termed benign, but any of them may be followed by tertiary manifestations of the crippling and incurable form.

Exceptionally the disease is distinctly atypical in its development, deep ulcerating and infiltrating lesions appearing in the early secondary period.

This form of the disease is characterized by its acute course. Even the chancre exhibits a destructive tendency, resembling in its development phagedænic chancroid. Syphilitic fever, concomitant rheumatism, and anæmia are well marked. The first eruption quickly becomes pustular, and ulcers form which are deep enough to leave pigmented scars on the skin, and in the mouth and nose to involve the superficial bones and cartilages, causing necrosis and deformity. Deep ulcers and ulcerating gummata appearing in the secondary period are especially characteristic of this form of syphilis. Recurrences following hard upon one another are also typical of malignant syphilis, while early involvement of the bones, the nervous system, and the viscera is not uncommon. In the latter case syphilitic marasmus and death often result.

The malignant form of the disease seems to depend not only upon the type of infection, but also upon lessened tissue resistance. Thus, syphilis is prone to exhibit its malignant form in the weak, the anæmic, chronic drunkards, the scrofulous, the tuberculous, the malarial, and in pregnant or nursing women.

There is both clinical and laboratory evidence to show that there are spirochætal strains, exhibiting predilection for certain systems; thus there are syphilitics whose late gross lesions are confined to the bones, others who exhibit

only involvement of the central nervous system, and others in whom eye lesions are dominant.

Periods of Syphilis.—In accordance with its clinical course the phenomena of acquired syphilis are classed under certain periods.

1. *The Period of Primary Incubation.*—The time intervening between exposure to contagion and the appearance of the chancre. This is, on an average, three to four weeks; its extremes are twelve days and three months.

2. *The Period of Primary Symptoms.*—The chancre develops and the anatomically related lymph-nodes become enlarged. This symptom-complex requires from three to ten days for its characteristic development.

3. *The Period of Secondary Incubation.*—The time elapsing between the appearance of the chancre and the development of secondary symptoms. This is, on an average, six to seven weeks, and includes the period of primary symptoms.

4. *The Period of Secondary Symptoms.*—Anæmia and neuralgic pains, slight fever, periosteal, visceral, and meningeal congestions, eye lesions, and the syphilides of the skin and mucous membranes develop during this period. This is, on an average, from twelve to eighteen months.

5. *Intermediate Period.*—During this time the patient may be entirely free from any signs of syphilis, or he may suffer from slighter, more irregular, less symmetrical, and less generalized symptoms than those of the secondary stage. Children begotten by a patient in the first half of this stage of the disease often show the signs of hereditary syphilis. This period lasts from two to four years. It may terminate in complete recovery or may be followed by:

6. *The Period of Tertiary Symptoms.*—This is characterized either by the formation of gummata or by diffuse infiltration of various organs. Chronic periostitis and ostitis, skin diseases of the tuberculo-ulcerous type, diffuse or circumscribed visceral infiltration, disease of the nervous system, are encountered during this stage. In the majority of properly treated cases the lesions of this period never appear; though they may develop at any time subsequent to the chancre, they commonly are seen in the third and fourth years following the primary lesion.

This division of syphilis into periods is roughly indicative of the course of the untreated or inadequately treated disease; one period runs insensibly into another. Lesions of primary, secondary, and tertiary syphilis may all be present at the same time.

CHAPTER XXXIV

SYPHILIS—(Continued)

THE PERIOD OF PRIMARY INCUBATION

Although the virus of syphilis does not remain localized during the entire period elapsing between inoculation and the appearance of the chancre, it remains at or near the seat of inoculation a certain length of time, and hence for a brief period may be reached and destroyed by mechanical cleansing and applications toxic to the infection.

It is possible that syphilis may be acquired from contact with the virus through unbroken surfaces, especially where the epidermis is extremely thin; but the presence of fissures or of abrasions greatly facilitates the contraction of the disease.

As a rule, it is safe to assume that any sore which appears more than ten days after the last exposure to contagion is a chancre. During the period of primary incubation there are neither general nor local symptoms; nor can a positive Wassermann reaction be obtained.

THE PERIOD OF PRIMARY LESION

After the period of primary incubation the primary lesion of syphilis, a *chancre*, develops. This begins as a spot of erythema, which in a few hours becomes a superficial papule; it gradually extends in circumference and depth, loses its epithelial or epidermic covering, and in the course of a few days is surrounded by an area of induration. This represents the development of a typical chancre. Frequently, however, the chancre when first seen appears as a fissure or an abrasion, or, if located on the mucous membrane, as a superficial ulceration covered by a grayish or yellowish false membrane.

There may be no break in the continuity of the epidermis overlying a chancre, but merely a gradual thinning of this layer of the skin from the margins towards the centre.

The well-developed typical ulcer appears as a cup-shaped depression, with sloping margins and smooth surface, covered centrally by a tough gray false membrane; beneath this there is a granulating surface, which bleeds readily on mechanical interference.

The chancre is usually single. When the virus has been inoculated at the same time in several places a number of sores may appear, but they all develop at the same time, and are never due to inoculation of surrounding or opposing surfaces with the discharge of a first sore. Multiple chancres occur in eighteen per cent. (Fournier) of cases.

Induration.—In from five to ten days the most characteristic feature of chancre, the induration, becomes perceptible, reaching its maximum in about two weeks from the appearance of the sore. It is distinct in the great majority

of cases, but may appear in different forms. It is due to the thickening of the blood-vessel walls, in conjunction with the cellular infiltration.

The blood-vessels of the skin form two horizontal networks—one beneath the papillæ, the other in the deepest portion of the derm. When only the superficial network of vessels is sclerosed there is simply a surface thickening (laminated or parchment induration); when both networks, together with the intermediate branches, are affected, there is a distinct nodule, varying in thickness according to the extent of skin surface involved (nodular induration). The vascular sclerosis is continued far beyond the area of induration, but usually to such a slight degree that the line of demarcation between the borders of the chancre and the surrounding tissue is distinctly marked.

The induration of the chancre is best detected by gently pinching together the soft parts wide of the lesion till the hardened edges are felt by the thumb and finger placed on opposite sides of the sore; the whole plaque is then lifted upward from the subcutaneous tissues, when, by further gentle pressure and palpation, the depth and extent of the induration can be readily determined.

It varies, in some degree, in accordance with the seat of the primary lesion. When occurring upon the glans penis, upon the inner layer of the prepuce, or in the fossa glandis, the chancre is usually very distinctly indurated. Upon the skin of the penis and the general integument induration is not so marked. In women the induration of the primary lesion is far less distinct than is the case with men; when the chancre is situated upon the labia majora the characteristic hardening is more pronounced than when it involves the labia minora or the fourchette.

The chancre commonly heals in four to six weeks, the induration lasting not much longer than this; if it has been distinctly nodular in character, it may persist for months and even years, or, after having entirely disappeared, may again become marked, constituting a form of the so-called pseudo-chancre.

Location of the Chancre

Genital chancres are those placed on or about the genitalia. The great majority of chancres, especially in men, are genital or perigenital.

Chancres elsewhere placed are termed extragenital. The disease when acquired in ways other than by normal or perverted sexual congress is termed *syphilis insontium*. The extragenital chancre may be found on any surface exposed to contact with syphilitic virus. The usual seats of such chancres are the lips, the mucous surfaces of the mouth and pharynx, the region of the anus, and the region of the nipple. In the mouth the chancre is commonly found on the tongue, exceptionally on the tonsils or the half-arches. Among surgeons, accoucheurs and nurses extragenital chancre is usually found on the fingers or hand. With very few exceptions, extragenital chancres are acquired in innocent ways; even the anal chancres often noted in women are commonly due to infection by discharges flowing backward from the vagina. Extragenital chancres rarely present the typical features of the sore as observed about the genitalia. At times the lesions are so slight as to excite scarcely any attention; more commonly inflammatory symptoms become so pronounced that character-

FIG. 368.—Chancre of the reflected layer.

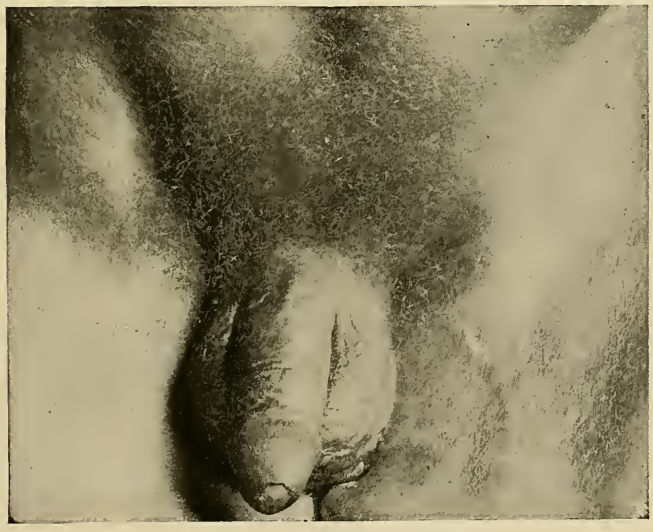


FIG. 369.—Chancre of the meatus.

istic induration, if present, is entirely masked, and, except in the clinical history of the case, there is nothing to suggest that the sore is syphilitic in nature. Chancres of the face and lips are often much larger than the average genital chancre, and sometimes form huge ulcers.

The Genital Chancre.—The common position of the genital chancre in men is on the inner layer of the prepuce in or just behind the coronary sulcus (Figs. 368 and 369), on the surface of the glans penis, particularly in the region of the frænum, and about the margin of the preputial opening. Three-fourths of all chancres are in these localities. The primary sore is found at times at the meatus urinarius, on the skin of the penis (Plate XII), on the groin or the scrotum, and in the urethra. The characteristic induration is most marked in those chancres found at the seats of preference—*i.e.*, on the inner layer of the prepuce just behind the sulcus. Upon the surface of the glans, in the region of the frænum, and about the urinary meatus the sore frequently assumes a distinct inflammatory type (Fig. 370).

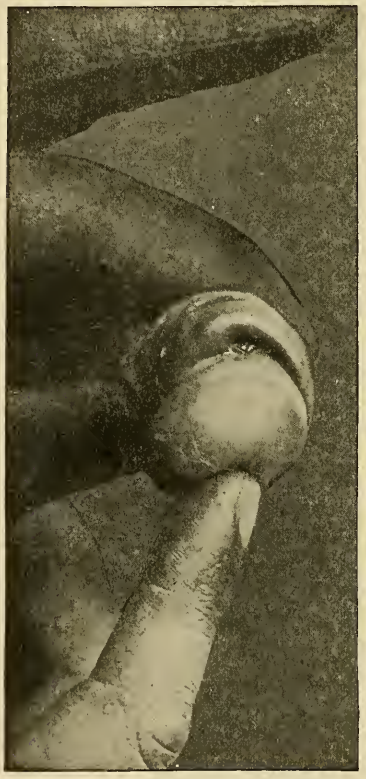


Fig. 370.—Chancre of the coronary sulcus.

On the free edge of the prepuce the induration may be absent or may form a ring of great hardness.

In women chancres are commonly placed on the labia majora or labia minora. They are not infrequently found in the regions of the fourchette and the clitoris, and have occasionally been observed about the os uteri. They are rare upon the surface of the vagina, although this canal is probably more exposed to contagion than any other surface. This immunity is due to the structure of the vaginal mucous membrane, which, being guarded with thick layers of flat epithelial cells, and having no glandular orifices, forms an efficient barrier against microbic infection. The inguinal lymph-nodes are primarily involved only when the lesion is placed in the anterior third of the canal.

The typical sharply circumscribed cartilaginous hardening is rarely observed in women; it is replaced by a more diffuse and less sharply marked infiltration, often little greater than would attend a non-specific lesion of the same size.

Varieties of the Genital Chancre.—Although the primary lesion may appear in a great variety of forms, the majority of cases present certain characteristic features, enabling them to be considered under a few headings.

In the order of their relative frequency chancres may be classed as:

1. Chancrous erosions.
2. Chancrous ulcerations.
3. Indurated papules.

PLATE XII.

Chancre on shaft of penis.

Exceptionally there are observed certain erratic forms of chancre which would not strictly fall under any of these headings. Among these are encountered:

1. The multiple herpetiform chancre, closely resembling herpes, but not presenting the multiple circinate margin of the latter, not giving the characteristic exudation of herpes on pressure, and having a different clinical history.

2. The "silvery spot," a lesion such as would be produced by the application of a finely pointed silver nitrate stick, generally situated on the surface of the glans penis, and often giving place finally to the chancrous erosion.

3. The mixed chancre, a lesion which results from the action of both the chancroidal and the syphilitic virus. The chancroid runs its typical course and may be healed before the syphilitic induration is noted. More frequently there is a persistent chancroidal ulceration, around which the hardening of the true chancre appears at its regular time.

1. *The Chancrous Erosion.*—About two-thirds of all genital chancres appear in the form of chancrous erosions. The lesion at first looks like a small abrasion, such as might result from a very slight scratch with the finger-nail. As the chancre develops it becomes oval or round in shape, is surrounded by a dusky-red areola, presents a polished raw surface, the central portion of which is covered by a gray false membrane, and discharges a small quantity of blood-stained serum. The lesion is an exfoliation of the epiderm, exposing but not destroying the true skin. The induration develops in about a week from the beginning of the erosion, and is usually parchment-like, though it may be nodular.

2. *The Chancrous Ulceration.*—This form of chancre exhibits a deeper ulceration than the chancrous erosion. The latter causes epithelial desquamation; the former involves the true skin, or, in its more exaggerated form, the subcutaneous tissues.

The chancrous ulceration may be superficial or deep.

The superficial form of chancrous ulceration, called by Fournier the exulcerative chancre, attacks the true skin, but does not entirely destroy it. An ulcer is formed of moderate depth, with sloping edges and a scanty sero-sanguineous discharge.

The granulating surface is frequently covered by a gray adherent false membrane. The induration is more marked than in the chancrous erosion, being rather of the nodular than of the parchment variety.

The deep form of chancrous ulceration, called by Fournier the ulcerative chancre, is comparatively rare.

There is formed a deep ulcer with sloping edges, moderate sero-sanguineous discharge, and typical extensive cartilaginous induration into which the ulcer seems to have eaten.

3. *The Indurated Papule.*—This primary lesion of syphilis differs from the chancrous erosion in the fact that the skin is not broken. A hard, raised, dusky-red tubercle is formed, sharply defined from the surrounding tissues. The surface is dry, but is frequently crusted with layers of exfoliated epithelium. The papule may be large and prominent, or so small as to escape the notice of the patient.

Complications of Chancre

The types of genital chancre just described may be so modified that they present an appearance entirely different from that commonly supposed to be characteristic of the primary lesion of syphilis.

The modification may be brought about by: 1, simple inflammation; 2, chancroidal inflammation; 3, papillary growth; 4, conversion into a mucous patch; 5, phagedæna and gangrene.

Simple inflammation may attack a chancre as a result of inoculation with the ordinary microörganisms of suppuration. This will be more likely to take place if the chancre is exposed to irritating applications, to friction, or to any mechanical injury which will render the soil favorable to the multiplication of pyogenic microbes. The chancre will be modified by the local signs of acute inflammation—namely, heat, pain, redness, swelling, and free discharge. As a further complication, suppurating buboes may form in the groins.

Chancroidal Inflammation.—The virus of chancroid and that of syphilis may be inoculated at the same time. In this case the chancroid will appear first, and may even have run its course and be completely cicatrized before the characteristic induration of the chancre is noted. More commonly the chancroid persists, the spreading, inflamed, sloughing-punched-out, freely discharging ulcer becoming gradually enveloped in a hardened infiltrate as the period for the full local development of the syphilitic lesion is reached. In place of being acquired at the same time, the chancroidal virus may be inoculated on a well-developed chancre; the result of this will be the formation of a chancroid, the induration being the only remaining local symptom to suggest chancre. If the chancroid spread rapidly it may cause sloughing of the indurated area, in that case leaving no local sign which would suggest syphilis; or the syphilitic virus may be inoculated on the chancroid, the latter then running its course unaltered except for the formation of an induration.

A sore resulting from the inoculation of both syphilis and chancroid at the same spot, a mixed chancre, is liable to any of the complications which follow the inoculation of either of the poisons separately.

Papillary Outgrowth and Conversion of the Chancre into a Mucous Patch or Condyloma.—Associated with the chancre there may be an abundant outgrowth of warts, such as are common in balanoposthitis or other inflammatory conditions of the glans and the prepuce. These warts seem to be due simply to irritation, and are not specific in their nature. The chancre itself at times loses its induration as secondary symptoms develop, becomes covered with gray false membrane, and presents all the characteristics of a mucous patch; or the papillary layer of the skin may proliferate, forming a condyloma, a broad, flat elevation, the surface of which is covered with a gray, adherent pellicle.

Phagedæna and Gangrene.—Phagedæna may be regarded as the result of inflammation more rapid and intense than that which characterizes the inflamed chancre. The engorgement becomes so great that there is loss of vitality, and sloughs are formed, or gangrene may attack the tissues. More rarely it progresses slowly, the ulcerating process being then termed *serpiginous.*

Phagedæna is more liable to occur in persons of depressed constitution, yet

it is noted at times in the robust. There is undoubtedly a systemic predisposition, which is in many cases successfully combated by specific treatment; the exciting cause is, however, purely local; this is shown by the fact that in the same person one sore may become phagedænic while another pursues an uncomplicated course.

Phagedæna may attack the chancre at any stage of its development, or may complicate any of the secondary or tertiary ulcerations of the disease. If rapid, it destroys the induration more quickly than it can form, and thus removes the most characteristic feature of the chancre.

Diagnosis of Chancre

In its early development chancre cannot be recognized as such by inspection or palpation. Since early diagnosis is of major importance, all inflammatory genital lesions which cannot be accounted for on the basis of recent (three days') exposure or slight trauma, and which cannot with assurance be given a different diagnosis, should be regarded as possibly syphilitic on their first appearance, as probably syphilitic if two or three days of cleanliness and protection do not accomplish their marked betterment or cure, as surely syphilitic if in from five to seven days induration and typical inguinal adenitis develop.

The primary lesion of syphilis may present only the features of a simple ulcer. A positive opinion cannot be given from the examination of the sore alone.

The absolute diagnosis of chancre is made by finding the treponemata (see Chapter XLIII).

In the absence of microscopic examination, an opinion as to the nature of a genital sore will be formed after due consideration of the following points:

1. *Confrontation,* or examination of the person from whom the lesion was presumably acquired. Even though he or she is found to be suffering from symptoms of primary or secondary syphilis, the lesions are not necessarily specific; they may be of mechanical, herpetic, or chancroidal origin. This method of diagnosis is rarely practicable.

2. *The History of Incubation.*—A lesion developing in less than five days from exposure is certainly not specific. One developing in from ten days to five weeks is probably specific, unless some other cause, such as mechanical or chemical irritation, or fresh exposure, can be assigned for it, or unless it be frankly herpetic or transitory.

3. *The Development of the Lesion.*—When this begins as a macule, or slight painless excoriation, or scratch, which persists in spite of careful local treatment, which slowly spreads without marked inflammatory symptoms, which becomes distinctly hard peripherally and at the base as though there were a dense cellular infiltrate, and which gives a thin, scanty discharge, showing a tendency to crust or to form a pseudo-membranous deposit covering the excoriated surface, the diagnosis of chancre can be made with considerable confidence.

4. *Induration.*—When the lesion, be it papule, erosion, or ulcer, develops the laminated, parchment, or nodular induration, a sharply circumscribed hardening, spreading wide of the central lesion and absolutely unlike the general thickening about an area of simple inflammation, it is almost certainly a chancre.

5. *Lymphatic Involvement.*—If the dorsal lymph-vessels of the penis become thickened and hard, and lymph-nodes of the groin steadily increase in size and hardness, without accompanying pain or other symptom of acute inflammation, forming a chain of little tumors, including several or all of the inguinal nodes of both sides, the evidence as to the specific nature of a genital lesion is still further strengthened.

The chief considerations on which a clinical diagnosis is founded are, the period of incubation, the presence or absence of induration, and the condition of the anatomically related lymph-nodes, and, most important of all, the persistence of the lesion.

Difficulties of diagnosis are greatest during the first week or ten days, and steadily diminish with the age of the lesion, which, if syphilitic, is almost certain to show the characteristics of the chancre. Confrontation is seldom practicable. The history of incubation is often vague and uncertain, and the development of the lesion is rarely studied attentively by the patient.

Induration is present in the great majority of chancres, and when typically developed is almost enough to justify a positive diagnosis. Induration, however, may fail as a diagnostic sign, since—1, it may be absent or but slightly developed; 2, it may be masked; 3, it may be present in non-specific ulcers; 4, it may be present in relapsing chancres.

The initial lesion sometimes appears as an infecting balanoposthitis, differing from ordinary balanoposthitis only in thickening and hardening of the prepuce, but slightly greater than that observed as a result of simple untreated inflammation; or syphilis may be inaugurated by the multiple herpetiform chancre, which may become indurated to only a moderate degree.

Induration may be masked by cellular infiltration dependent upon acute inflammation attacking a chancre, or may be entirely destroyed by a rapid phagedænic process.

Certain non-specific sores may present induration so like that of the chancre that differential diagnosis founded on this sign alone cannot be made. A simple sore which has been treated by caustics will frequently take on induration. A forming furuncle, the inflamed orifice of a suppurating vulvo-vaginal gland, a tubercular ulcer, an isolated lesion of scabies, may all present a circumferential induration which will make immediate diagnosis impossible.

The so-called relapsing chancre, generally a tertiary lesion, may, with the exception of the inguinal adenopathy, exactly simulate the primary sore of syphilis.

The involvement of the anatomically connected lymph-nodes is absent as a rare exception; when typical it is highly characteristic. It must be borne in mind, however, that:

1. Many non-syphilitic patients exhibit hard, movable lymphatic tumors in both groins.

2. Simple sores sometimes cause enlargement of several nodes with very slight inflammatory phenomena. Occasionally, from mixed infection, syphilitic buboes exhibit marked inflammatory reaction.

3. Chancre may be followed by secondary syphilis without involvement of the anatomically related lymph-nodes.

PLATE XIII.

Chancre of the corona. (Fox.)

The Differential Diagnosis of Genital Chancre

Since ulcerative lesions of the genitalia may be due to a variety of causes, and since, even though different in their nature, they may present some features in common, the question of differential diagnosis becomes one of great importance.

To distinguish between a " mixed chancre " and a chancroid or simple veneral ulcer is often impossible. Even should a chancroid be absolutely typical in all its clinical features, it is not safe to make a positive statement that syphilis will not develop. If, in spite of the favorable course of a simple ulcer, after two or three weeks characteristic induration develops, and in another seven days the inguinal nodes on both sides painlessly enlarge one after another, the probability of syphilis and chancroid having been inoculated at the same point is great. Per contra, if a non-inflammatory indurated sore appears at an interval of more than ten days after exposure, and in consequence of further exposure rapidly assumes an inflammatory type, sloughs, and extends beyond the area of induration, destroying the latter, and presenting on examination only the features of the simple venereal sore, the probability is that the lesion is a mixed chancre, the chancroidal virus having been inoculated upon the primary lesion. This probability is made still stronger if painless multiple enlarged lymph-nodes are found in the groins. Even should a suppurating bubo form, this should not influence the diagnosis in regard to syphilis, since each disease will run its course independent of the other.

The differential diagnosis between chancre, chancroid, aside from the microscopic identification of the treponema or the Ducrey bacillus, and herpes will depend upon a consideration of the characteristics of each as given in the following table:

Chancre.	*Chancroid.*	*Herpes.*
Origin.—Due to inoculation with the blood or lesion-discharges of a syphilitic.	Due to inoculation with the discharge of a chancroidal sore. Possibly caused by pus from other sources.	Due to— (1) Mechanical irritation, as in sexual intercourse. (2) Chemical irritation, such as is produced by acrid discharges or by uncleanliness. (3) To neuroses; often following fever, and particularly occurring in syphilitics.
Incubation.—From ten days to twelve weeks. Average about three weeks.	No definite period. It may not be noticed for two or three days.	None.
Situation.—Generally on the genitalia. Often on lips, tongue, nipples, and hands.	Generally on the glans penis and the prepuce. Rarely on other genital surfaces. Hardly ever on other parts of the body.	Generally on the glans penis and the inner layer of the prepuce, the lips, or tongue. Plate XII.
Number. — Single; at times simultaneously multiple.	Frequently multiple, often on opposing surfaces by auto-inoculation.	Multiple. Ultimately may be confluent.
Beginning. — Begins as an erosion, papule, tubercle, or ulcer. May remain without ulceration through its entire course.	Begins as a pustule or an ulcer. Always ulcerates.	Begins as a group of vesicles, which may coalesce or may ulcerate singly.

	Chancre.	*Chancroid.*	*Herpes.*
Shape.—Round, oval, or symmetrically irregular.	Round, oval, or unsymmetrically irregular, with border described by segments of large circles.	Irregular, circinate borders, representing segments of small circles; sometimes separated.
Depth.—Usually superficial, cup-shaped, or saucer-shaped, or may be elevated.	Hollow, excavated, or "punched out."	Superficial.
Surface.—Smooth, shining, dusky red, glazed; diphtheroid membrane, or scab or epithelial crusts.	Rough, uneven, "worm-eaten," warty, grayish, pultaceous slough.	Bright red superficial granulations, sometimes covered by diphtheroid membrane.
Secretion. — Scanty, serous, hardly ever auto-inoculable, except in cases of mixed infection, when a chancroidal sore may be produced. On squeezing no discharge is expressed.	Abundant, purulent, readily auto-inoculable.	Moderate secretion, auto-inoculable with difficulty. On squeezing a small serous drop exudes. When this is wiped away, another drop can be pressed out. This can be repeated several times.
Induration. — Usually present; firm, cartilaginous, or parchment-like; sharply circumscribed; movable upon subjacent parts. Prolonged pressure by the examining fingers does not produce any change in it; usually persistent; disappears under specific treatment.	Exceptionally present. Due to caustics or other irritants, or to simple inflammation; boggy, inelastic, shades off into surrounding parts, to which it is adherent; disappears soon after cicatrization. Prolonged pressure causes changes in shape, such as are noted in œdema.	No induration.
Sensibility.—Very rarely painful.	Often painful.	Often painful.
Course.—Grows slowly and, as a rule, painlessly larger, in spite of any but specific treatment, for two to four weeks; it then slowly heals. Relapses and phagedæna uncommon.	Irregular; rapid extension; acutely inflammatory, destructive, and painful; runs its course in three to six weeks. Relapses and phagedæna not uncommon.	Easily and quickly cured (days). Sometimes spreads by the appearance of successive crops of vesicles. Lesions preserve the polycyclic form. Likely to recur, especially in syphilitics and in uncleanly patients with long foreskins.
Histology.—A new cell growth. Very little destruction of tissue. Scrapings often show more or less epithelium.	An ulceration, with more or less loss of substance. Scrapings show granulation-tissue.	Originally an elevation of the epidermis in spots by an effusion of serum.
Bubo.—Constant, painless, multiple, generally bilateral.	Appears only in one-third of the cases; painful, inflammatory, single, or a single one on each side.	Rare. When it does occur, painful inflammatory, single, or a single one on each side.

Chancre.	*Chancroid.*	*Herpes.*
Prognosis.—Good locally; ulceration is at the expense of the infiltrate: hence there is little ultimate scarring; constitutional syphilis follows in the great majority of cases.	More serious locally, for there is tissue destruction. May refuse to heal or may become phagedænic. Never followed by syphilis (unless mixed).	Always good. Recurrences are frequent, especially in syphilitics. (The herpetic chancre closely simulates herpes).
Treatment.—Rapidly cured by systemic treatment.	Local treatment is slowly curative. (Usually rapid healing after cauterization).	Local treatment is rapidly curative. Tendency to spontaneous cure.

When phimosis is present, so that a lesion of the glans or of the under surface of the foreskin cannot be exposed, it is difficult to determine whether such a lesion is chancrous or is due to inflammatory processes of a different nature. In such cases a diagnosis must be made after a consideration of the following points of difference:

Subpreputial Chancre.	*Non-Syphilitic Subpreputial Ulceration.*
Incubation.—Never less than ten days. Usually three weeks; may be more.	*Incubation.*—Rarely none. Inflammatory symptoms become pronounced in less than ten days.
Number.—The lesion is usually single. (This may be learned from the history of the case before phimosis developed, or from palpation.)	*Number.*—The lesions are usually multiple.
Inflammation.—Acute symptoms absent or but slightly marked.	*Inflammation.*—Acute symptoms very pronounced. (Heat, swelling, pain, redness.)
Swelling.—Hard, characteristic circumscribed induration. Can often be isolated from surrounding tissues and raised and felt between the thumb and finger.	*Swelling.*—Diffuse, œdematous general inflammatory infiltration. Cannot be isolated or felt as a circumscribed induration.
Discharge.—Moderate, thin, at times blood-stained. Not readily auto-inoculable.	*Discharge.*—Often produces auto inoculation by accidental contact.
Preputial Orifice.—Not markedly ulcerated.	*Preputial Orifice.*—Almost invariably ulcerated.
Buboes.—Non-inflammatory, bilateral, inguinal buboes always develop.	*Buboes.*—Single, inflammatory, suppurating buboes often develop.

Concealed Genital Chancres.—Typical chancre may develop about the genitalia, yet from the fact that it is so placed as to be concealed from view it may not be detected; thus chancres of the cervix uteri and chancres of the urethra are not usually recognized as such till constitutional symptoms develop.

Chancre of the cervix uteri is probably more common than is generally believed. It is often not discovered because the lesion thus placed produces no pain and but very slight discharge: hence there are no symptoms which would lead a patient to present herself for examination.

The chancre is nearly always situated at the margin of the os, and presents the same variations in size and surface as are noted in primary sores of the external genitalia. It may appear as an erosion, as a deep ulceration with a smooth pseudo-membranous surface, or as a papillary outgrowth. It may be no larger than a split pea, or may present a raw surface the size of the thumb-nail. Induration, though present, cannot be felt, owing to the position of the lesion. Chancre of the cervix must be distinguished from *ulcerating folliculitis,* from *mechanical erosions and ulcerations,* from *herpes,* and at times from *malignant growths.*

Ulcerating folliculitis is commonly associated with a chronic catarrhal condition, and produces small, often multiple lesions, extending very little beyond the limits of the follicle. These lesions promptly heal under appropriate treatment.

Mechanical erosions and ulcerations may closely simulate the specific lesion, but are less sharply circumscribed and do not show the characteristic regular development of the specific sore.

Herpetic lesions can be distinguished from chancre of the cervix by the fact that the former are usually multiple, often coalesce, presenting a circinate margin formed of the segments of many circles, and heal rapidly.

Cancer occurs at an age when chancre is not common; its course is often painful and always progressive. It causes deep ulceration and steadily infiltrates surrounding tissues. If at first glance a chancre resembles cancer, the further progress of the case will shortly decide the diagnosis.

Chancre of the Meatus.—When the sore involves the meatus it looks more like a chancroid than like a chancre (Fig. 369). From frequently repeated irritation incident to the flow of urine, the lesions become distinctly inflammatory in type; they are ulcerative and destructive, showing jagged, punched-out borders, and but moderate induration, best detected by taking the end of the glans between the thumb and the forefinger and squeezing it in an antero-posterior direction. Permanent cicatricial deformity is often left after they have healed. Chancre is perhaps more prone to develop at the meatus than is chancroid; hence a sore in this region should be suspected, even though it exhibits none of the clinical features of the syphilitic lesion.

Urethral chancre is often overlooked, not because of the absence of characteristic features, but rather because the lesion in this locality is so rare that methodical search is not made for it. As would naturally be expected, the chancre is generally at or near the meatus. It is rarely placed farther back than the fossa navicularis (see Syphilitic Urethritis).

EXTRAGENITAL CHANCRE

Errors or difficulties in diagnosis may arise from the fact that a chancre is extragenital.

As a rule, chancroid is found only about the genital organs: hence in other regions the question of distinguishing between this sore and chancre rarely comes up. The extragenital lesion is usually single.

Its favorite seats have been given.

Herpetiform erosions of the lips, papules on the tip of the tongue, scabby ulcerations of the skin, scratches which absolutely refuse to heal, chronic inflammations at the tips of the fingers, resembling felons, but without the accompanying acute inflammatory symptoms—all such lesions should be regarded with suspicion if indolent in course, obstinate to treatment, and accompanied by slight discharge which has a tendency to form crusts or a pseudo-membranous deposit on the eroded surface. If, moreover, such lesions are placed upon an elastic, sharply circumscribed, indurated base, and are followed by hard, painless enlargement of the nearest associated group of lymphatic glands, the diagnosis receives strong corroboration. It is made absolutely certain by finding the treponemata.

Chancres of the Head and Face

Razor-cuts on the chin, cheek, or lips which, after having healed, reopen and become covered with crusts, pseudo-furuncles or acneiform pustules, and cracks around the mouth or nose which persist, are painless, are surrounded by an area of inflammatory œdematous swelling, and give a thin, blood-stained discharge which exhibits a tendency to form crusts, should suggest the possibility of chancre, and should lead to repeated microscopic examination and palpation of the parotid and submaxillary lymph-nodes.

The primary sore of syphilis when it occurs on the scalp or on the bearded cheeks or chin closely resembles ecthyma. On removing the surrounding and covering hair, a glazed, flat, slightly elevated superficial ulceration is detected. When a patient presents himself with such lesion it is impossible from the local signs to determine whether or not the sore is specific. Early diagnosis must be made with the microscope. Painless enlargement and hardening of the nearest lymphatic nodes is strongly suggestive. The ecthymatous lesion begins as a flat pustule, surrounded by an acute inflammatory but non-indurated base, is generally multiple, and runs its course in two or three weeks.

The eyelids and the ocular conjunctiva may be the seats of primary sores. The lesion begins as a papule, which gradually becomes indurated and eroded or ulcerated, presenting the characteristic sloping edges and hard base of chancre. This lesion has often been mistaken for a stye; its development, persistence, and the absence of acute inflammatory symptoms should suggest a microscopic examination in a few days. Lymphatic enlargement is first noted in the nodes in front of the ear and at the angle of the jaw.

At times chancre of the head and face attains enormous size, differing entirely in appearance from the primary lesion of syphilis as ordinarily observed; induration may be absent, and occasionally acute inflammatory symptoms are pronounced. Such cases are often not recognized till the appearance of the secondary eruption.

Chancre of the Lip.—Chancre of the lip in its beginning closely simulates ordinary non-specific sores. It often begins as a chap or fissure, frequently found in the median line, as an aphthous lesion, on an ulceration such as would be produced by the burn of a cigar or of a cigarette. In the early stage there

FIG. 371.—Chancre of the lip.

FIG. 372.—Chancre of the lip.

Chancre of lip.

is nothing characteristic about these lesions, but in a few days the extension of the erosion or ulcer, with its pseudomembranous covering, and the formation of a characteristic and usually very pronounced and extensive induration indicate the nature of the affection (Plate XIV, Fig. 371). The diagnosis is made still more positive in the course of one or two weeks by enlargement of the submental lymph-nodes.

The whole lip is generally congested and swollen, sometimes reaching an enormous size (Fig. 372). At times the induration of lip chancre is so great and the ulcerating process so marked that on first inspection it seems to be malignant. The fact that chancres have been excised because they were mistaken for epitheliomata, thus entailing on a patient unnecessary mutilation, justifies a tabulation of the points of difference between the two affections, by a consideration of which the nature of each may be correctly determined.

Labial Chancre.	*Labial Ephithelioma.*
History.—Sometimes a history of exposure to syphilitic inoculation.	*History.*—Sometimes a history of cancer in the family.
Age.—Occurs at any age.	*Age.*—Occurs nearly always after middle life.
Sex.—Affects males and females differently.	*Sex.*—Hardly ever affects females.
Seat.—Involves either lip.	*Seat.*—Almost always involves lower lip.
Local Symptoms.—A painless elevated sore, regular in outline with a smooth surface and a circumscribed, dense induration. A scanty, odorless discharge.	*Local Symptoms.*—An irregular, ragged, often painful sore, bleeding easily, and irregularly indurated. An offensive discharge.
Course.—The sore develops in a few weeks at most, often in from seven to ten days. It is followed in one or two weeks by submaxillary lymphatic enlargements, and in from six to eight weeks by secondary symptoms.	*Course.*—The sore develops very slowly—a matter of months. The lymph-nodes are involved only after several months.
Therapeutic Test.—Mercury and arsenic cause the prompt disappearance of the chancre.	*Therapeutic Test.*—Mercury and arsenic have no beneficial effect upon the epithelioma.
Microscopic Examination.—The chancre shows a small, round-celled infiltrate, particularly along the course of the blood-vessels. Treponemata found by appropriate methods.	*Microsopic Examination.*—The epithelioma shows the pearly bodies.

Chancre of the Tongue.—The primary lesion of syphilis is less common on the tongue than on the lips. It usually involves the anterior half of the organ, and is found on the dorsal surface, the sides, or the tip.

It commonly assumes the erosive form, presenting an appearance almost identical with that of similar genital lesions. There is simply a painless, oval, or rounded superficial lesion, with smooth surface, frequently covered by a grayish pseudo-membrane seated upon a parchment-like induration (Figs. 373 and 374). It is often as large as a ten-cent piece. The supra-hyoidean and sometimes the submental lymph-nodes first exhibit the specific enlargement.

The ulcerative form of lingual chancre exhibits a deep lesion, often upward of an inch in diameter, with sloping edges, and dense, well-marked induration.

However easy the diagnosis may be when the chancre is well developed, in the first stages lingual chancres closely simulate non-specific lesions. An early diagnosis is extremely important in these cases, since failure to recognize the syphilitic nature of the disease may result in its transmission to healthy persons. If an ulceration apparently produced by carious teeth, or a papule arising without given cause, fails to heal in five or six days, but, on the contrary,

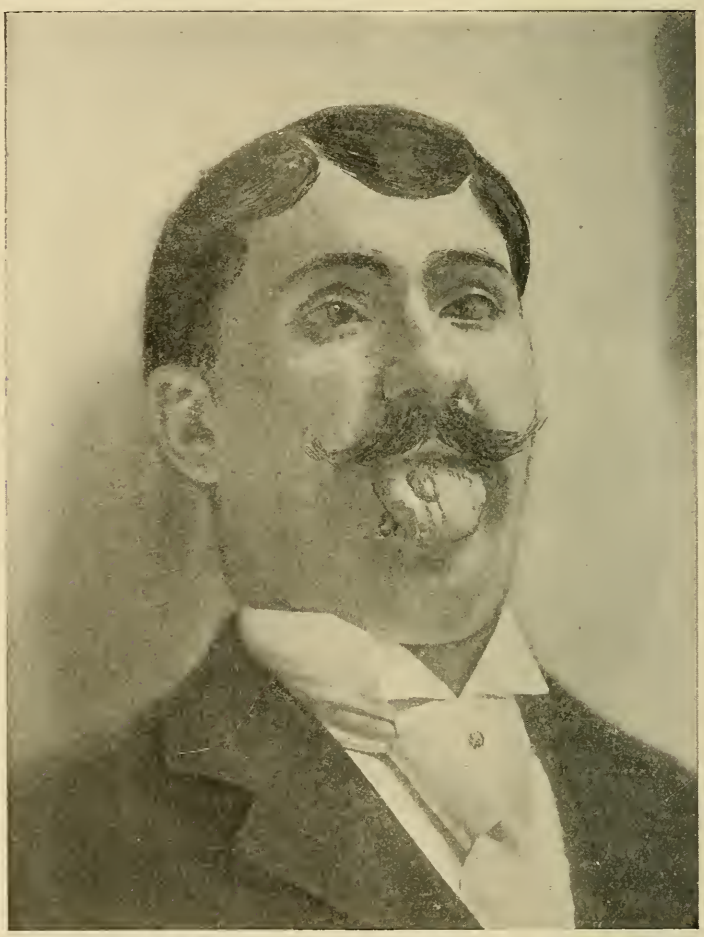


FIG. 373.—Chancre of the tongue. (From the collection of photographs of Dr. George Henry Fox.)

enlarges, becomes elevated, is eroded, is covered with pseudo-membrane, and is not made better by mild applications, the lesion may be looked on with great suspicion, which will deepen into almost certainty with the appearance of induration and lymphatic enlargement.

CHANCRE OF THE TONSILS AND FAUCES.—Chancre is rare in these regions, and when observed is so masked by concomitant inflammatory symptoms that

diagnosis is usually impossible. The lesion as described presents the appearance of a mucous patch, which is single, and, if it can be palpated by one finger in the pharynx and the other external to its walls, is found to be indurated. There is a history of prolonged sore throat, and in one or two weeks the lymph-nodes at the angle of the jaw enlarge.

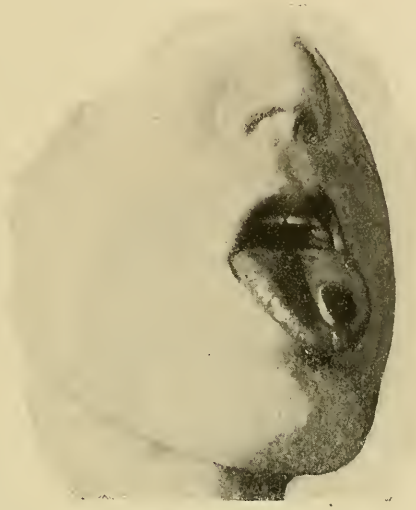


FIG. 374.—Chancre of the tongue.

Primary syphilis of the tonsil is observed in women much more frequently than in men.

The diagnosis should be suggested by the persistence of an irregular, often painful, ulcer. The whole tonsil is swollen; the submaxillary and upper deep cervical lymph-nodes enlarge. The diagnosis, which can be made quickly with the microscope, is generally made only after the appearance of characteristic secondary lesions.

Chancre of the Breast

The lesion is usually caused by a syphilitic infant nursed by a healthy woman: hence it is in women that it is nearly always observed, though a few cases have been reported in men, with a different etiology.

The sore may appear either about or upon the nipple, or upon the skin covering the mammary gland. In the latter case it usually exhibits the characteristic features of chancre as found on the genitalia, being commonly of the erosive or the ulcerative type and rarely offering diagnostic difficulties.

When the lesion is situated on the nipple or at its base, the sore very closely simulates non-specific affections, such as simple fissure, mechanical erosion or ulcer, or even beginning eczema. If, however, a lesion so apparently simple, instead of healing under treatment, slowly extends, if it is accompanied by little or no pain, if it gives a scanty, blood-stained discharge which has a tendency to crust, and, most important of all, if it exhibits distinct induration and painless, non-inflammatory lymphatic enlargement in the axilla, the diagnosis of chancre can be made with some certainty.

Suspicious lesions in a nursing woman should at once suggest an examination of the child she suckles. Secondary lesions in the mouth of the latter would constitute almost positive evidence as to the syphilitic nature of the breast lesions in the woman, provided she is not the mother of the diseased child (Colles's immunity).

Chancres of the Anal Region

Chancres of the anus are much more common in women than in men, from the fact that in the dorsal decubitus the vaginal discharges flow downward over the perineum and the anus and thus inoculate the cracks or abrasions which may exist in those regions.

The sore is usually placed at the anal margin, in one of the muco-cutaneous folds or puckerings incident to the normal contraction of the external sphincter. The ulceration often follows the line of these folds, thus producing an elongated or linear lesion; this becomes indurated, gives a scanty discharge, is refractory to local treatment, and is generally followed by characteristic enlargement of the inguinal lymph-nodes.

In place of the indurated linear ulcer, an anal chancre may appear as an excoriated papule, or, more rarely, as a typical cup-shaped, densely indurated, ulcerating chancre.

From the appearance of the anal lesion it is sometimes very difficult to determine whether it is a fissure, or a simple ulcer, or the primary sore of syphilis. The slow (two to four weeks), progressive development of the chancre will indicate the specific nature of the affection, even before induration and lymphatic involvement make the diagnosis almost positive.

Chancres of the rectum are exceedingly rare. A single, apparently causeless, refractory (week's) ulcer should suggest syphilis.

Chancres of the Extremities

Chancre is occasionally observed on the thighs, the anterior surface in men and the posterior surface in women being the regions of preference, on the antero-lateral surfaces of the forearm in both sexes, and particularly on the fingers at the margins of the nails. Occasionally it develops over a knuckle, inoculated through a wound caused by a blow on the teeth of a syphilitic. Except on the fingers, the chancre develops in a characteristic manner and offers no special diagnosis difficulties.

Digital chancres commonly appear at the edges or the base of the nail, starting as erosions, papules, or pustules, becoming indurated, elevated, and ulcerated, being accompanied by much swelling of the surrounding finger-pulp, and presenting the appearance of an ulcerating felon (Fig. 375).

The chancre, however, develops slowly, is not extremely painful, discharges but little, is not favorably influenced by local treatment, and is shortly followed by epitrochlear and axillary lymphatic enlargement. When the lesion involves the ring or the little finger, the node at the elbow, if present, is enlarged; the lymphatics from the thumb and from the index and middle fingers pass directly to the axillary nodes.

Sometimes the chancre may develop so insidiously and may form so insignificant a lesion, simply a small indurated papule, that even the patient's attention is not directed to it, and he has no suspicion of having acquired syphilis till the secondary lesions appear.

The early diagnosis of digital chancre is a matter of special importance to doctors and nurses, who form the class in which digital chancres are observed. Any painless lesion about the fingers giving a scanty discharge, steadily enlarging in spite of treatment, and becoming distinctly hard, should excite suspicion, and should lead to a careful examination for the treponema.

Vaccination Chancre.—When human lymph has been employed, this

Fig. 375.—Chancre of finger. Nine weeks' duration.

accident has occurred many times. If the vaccination takes, the pustule may run the typical course, and may be healed before evidences of the chancre appear. More commonly the healing of the ulcer resulting from the vaccinal suppuration is delayed; it presents a smooth surface, gives a scanty discharge, is unattended by pain, and characteristic induration develops. The associated lymph-nodes are enlarged, and secondary symptoms follow.

If the vaccination does not take, there may be no sign of trouble for fifteen to thirty days. Then an indurated papule is formed, which slowly ulcerates and offers all the peculiarities of erosive or ulcerative chancre. Sometimes the vaccination ulcer becomes acutely inflamed, even phagedænic, the inflammatory symptoms thus masking the syphilitic nature of the lesion: simple vaccinal phagedænism may, however, present some of the features of an inflamed chancre.

THE PROGNOSIS OF CHANCRE

Usually in three or four weeks, sometimes in as many months, the chancres become cicatrized, the induration disappears, and there is left a brownish scar, which may persist for years. This scar may retain its pigmentation as long as it remains perceptible; more commonly it becomes white.

Healing of the chancre will take place spontaneously, but will be greatly accelerated by specific treatment. Even in extensive ulcerating chancres, such as are observed on the cheeks or the lips, for instance, there is almost no ultimate deformity, since the destruction of tissue is mainly at the expense of the syphilitic infiltrate. If the chancre is attacked by phagedæna—which is rare—and if the sloughing process destroys the induration and passes wide of its limits, there may be resultant cicatricial deformity, but this will be due not to the specific poison, but to the destructive influence of other microbes.

Chancre of the conjunctiva may give rise to grave ophthalmia.

Chancre of the tongue or of the fauces may, through interference with mastication or deglutition, cause great debility, and chancre of the urethra is frequently followed by stricture.

The prognosis of syphilitic chancre considered as a local disease is, then, almost uniformly favorable. As to any relation existing between the source of contagion, the chancre, and the constitutional disease of which it is the precursor, the following clinical facts seem well established:

1. It is impossible to predict the form of chancre from the character of the source of infection. It is well known that the most widely differing forms of initial lesion may be acquired from the same individual.

2. The severity of the constitutional disease bears no relation to the form of the initial lesion. A dry papule may be followed by severe secondary symptoms, while an ulcerating chancre may precede a very slight form of constitutional involvement.

3. A short primary incubation has been shown experimentally to be indicative of a strong tissue resistance against the disease.

4. The amount of lymphatic involvement is as uncertain a prognostic guide, in regard to the severity of the constitutional disease, as is the type of chancre.

The treatment of chancre is described under the treatment of syphilis (see pp. 863 and 887).

Primary Lymphatic Involvement

Coincident with the development of the chancre there is a marked alteration in the associated lymphatic vessels (*lymphangitis*) and nodes (*lymphadenitis* or *bubo*).

Syphilitic Lymphangitis.—In about twenty per cent. of genital chancres there develops usually within the first week, and before the lymph-nodes are involved, a painless, often beaded hardening of the lymphatic vessels of the dorsum of the penis. They form a cord about the size of a match-stick, and may be felt starting from the region of the chancre and running up as far as the inguinal glands, though the hardening does not often extend more than two or three inches along the back of the penis. Unless there is mixed infection, the skin over these lymphatic vessels does not become discolored or adherent; except the induration, there are no signs of inflammation. There may be several of these indurated lymphatic vessels, forming small distinct cords.

The specific lymphangitis usually subsides with the induration of the chancre —that is, within three to five weeks; though, like the latter, it may last for several months.

The lymphangitis accompanying extragenital chancres and genital chancres of women can rarely be detected, owing to the less accessible position of the involved lymphatic vessels.

Syphilitic Lymphadenitis or Bubo.—The syphilitic bubo is, after the chancrous induration, the most characteristic and constant feature of primary syphilis. As commonly used, the term syphilitic bubo is applied only to those lymph-nodes with which the lymphatic vessels from the chancre directly communicate. In about a week from the appearance of the chancre these nodes undergo a painless enlargement. Since chancres are usually placed upon the genitalia, the inguinal nodes are the ones commonly affected. In accordance with the seat of chancre, the bubo will be placed as follows:

Genital and perigenital chancres (including those of the perineum and anus) involve the inguinal nodes; chancres of the lip and chin involve the submaxillary nodes; chancres of the tongue involve the suprahyoid or submaxillary nodes; chancres of the eyelid involve the preauricular nodes; chancres of the fingers involve the epitrochlear or axillary nodes; chancres of the breast involve the axillary nodes.

In genital chancre the node first affected is usually the nearest one of the chain on the affected side, though when the lesion is situated upon the side of the frænum a node of the opposite side may first enlarge. Subsequently, one after the other, several of the nodes or the entire chain become hypertrophied. This commonly takes place in both groins, though exceptionally it is limited to one side. On examination the nodes are felt, each distinct, hard, almond-shaped, painless, and freely movable.

There are often one large node and a group of from three to five smaller ones, each about the same size. Sometimes but a single node is enlarged; this is particularly the case with extragenital chancres, such as those of the lip. The enlargement is never very great, the ganglia rarely exceeding the size of a marble. The group of typically indurated nodes of the groin has been termed the "pléïade ganglionnaire."

Suppuration occurs in these nodes only as a result of mixed infection, the pyogenic microbes gaining access through the surface break caused by the chancre.

In very exceptional cases chancre is not accompanied by syphilitic bubo.

Diagnosis.—Since lymphatic vessels and nodes may be enlarged as a consequence of simple inflammation, and since the syphilitic bubo is one of the important means of diagnosing chancre, it is necessary to bear in mind the points of difference between syphilitic and simple inflammatory involvement of the lymphatics. These points of difference are as follows:

Syphilitic Lymphangitis.	*Inflammatory Lymphangitis.*
Cause.—Always a chancre.	*Cause.*—Chancroids, herpes, or other non-specific lesion.
Symptoms.—A hard, painless cord, unaccompanied by heat, redness, or tenderness. Erection painless. Little or no œdema.	*Symptoms.*—A cord not so hard nor so sharply circumscribed; often painful, especially on erection; tender and accompanied by heat, redness, and œdema of the overlying skin.

Syphilitic Lymphangitis.

Termination.—Undergoes resolution. Is uninfluenced by local treatment.

Syphilitic Bubo.

Cause.—Always chancre.

Number.—Several nodes, usually in both groins.
Time of Appearance.—Shortly after chancre; about one week.
Symptoms.—Small, indolent, painless, movable, non-inflammatory tumors, non-adherent to the skin, and of cartilaginous hardness.

Termination.—Resolution.
Treatment.—Local remedies without effect. General mercurial treatment hastens resolution.

Inflammatory Lymphangitis.

Termination. — Undergoes suppuration or resolution. Local treatment effective.

Inflammatory Bubo.

Cause.—Chancroid, herpes, balanoposthitis, gonorrhœa, or any non-specific lesion.
Number.—One node implicated. Rarely bilateral.
Time of Appearance.—At any time during the existence of a lesion.
Symptoms.—A large, tender, painful, acutely inflamed tumor, adherent to the skin, and causing redness and heat of the latter. The hardness is that of inflammation.
Termination.—Frequently suppuration.
Treatment.—Local treatment curative; general mercurial treatment useless.

The diagnosis of syphilitic buboes from the lymphatic enlargement so frequently noted in strumous patients must depend entirely on the history of the case and the development of the tumors. The strumous adenomata neither increase nor decrease in size unless they become inflamed, in which case they break down and suppurate. A tuberculous family history, together with other signs of struma about the patient, can often be elicited; there is no progressive involvement first of the lymphatics anatomically connected with the seat of the sore, then of all the lymphatics accessible to the examining fingers; and finally resolution does not partly or wholly take place in the majority of cases in from two to six weeks, nor is this resolution in the slightest degree quickened by the administration of mercury.

Treatment.—Syphilitic infiltration of the lymphatic vessels and nodes usually requires no treatment, subsiding spontaneously soon after the disappearance of the induration of the chancre, though the enlargement of the lymphatic nodes may persist for months, or, exceptionally, for many years. The administration of mercury, when the diagnosis has become so certain that its use is justifiable, causes a rapid disappearance of the specific infiltrate. In cases complicated by acute inflammation and suppuration the treatment is the same as that appropriate to chancroidal lymphangitis and bubo.

THE PERIOD OF SECONDARY INCUBATION

The period between the appearance of chancre and the development of secondary lesions varies from two weeks to three, or even six, months. The average time, however, is forty-two days. The primary lesion often remains during the whole of this period.

The disease, so far as constitutional symptoms are concerned, is apparently quiescent. In reality the virus is becoming disseminated through the entire system, first manifesting its effect upon the accessible lymphatic nodes not anatomically connected with the primary sore. Enlargement of these nodes usually constitutes the first secondary symptom, and is, except changes in the blood, the earliest positive sign of constitutional syphilis.

CHAPTER XXXV

SYPHILIS—(Continued)

Constitutional syphilis includes the period of secondary symptoms, the intermediate period, and the period of tertiary symptoms.

The period of secondary symptoms is characterized by:—1. Alterations of the blood. 2. General lymphatic enlargement. 3. Moderate fever, the temperature reaching 100° to 101° F. in the evening; often associated with malaise and anorexia. 4. Muscular and articular pains, about the chest, back, and upper extremities, usually moderate in severity, but sometimes very severe. 5. Alopecia, involving the hairy surfaces of the entire body, and causing ragged and irregular bald spots very unlike those incident to the ordinary atrophy of hair-follicles. 6. Eruptions of the skin and the mucous membranes.

Frequently associated with these manifestations are symptoms dependent upon involvement of the eyes, the nervous system, the bones and periosteum, the testicle, and the liver and other glands.

The term secondary syphilis has been applied to those lesions which appear during the first two or three years of the constitutional disease, and which are for the most part superficial; yet it must be remembered that secondary symptoms may never appear, the first manifestation of constitutional involvement occurring after one or two years in the deeper ulcerative form of surface lesions, or in the more serious visceral complications which characterize tertiary or late syphilis. When such deep ulcerative lesions are noted during the period when secondary symptoms should appear—that is, in the first few months of the attack—the disease is termed malignant syphilis. Conversely, during the period when tertiary eruptions and visceral complications ordinarily appear, and when such lesions are actually present, lesions particularly characteristic of secondary syphilis may develop, such, for instance, as papules of the skin or mucous patches of the mouth. Irregular syphilis is a term applied to cases thus differing in course from those ordinarily observed.

It will be remembered that the diagnosis of syphilis can be made clinically with absolute surety only when one or more of the constitutional symptoms develop. One of the first of these symptoms, and the one upon which diagnosis is usually founded, is enlargement of lymphatic glands at a distance from the chancre. Unless treatment be started at once, there will usually develop in a few days following this enlargement the secondary symptoms already mentioned—namely, fever, osteocopic pains, skin eruptions, mucous patches, sore throat, falling of the hair in patches, and at times iritis, orchitis, or jaundice.

Alteration in the Blood.—If systematic observations of the blood be made, there will be found a diminution in the hæmoglobin percentage and red corpuscles, with slight leucocytosis. These blood changes are the first sign of constitutional syphilis, preceding lymphatic enlargement by two or three weeks; they become more marked with the advent of fever and on the appearance of the eruption.

The appearance in the blood of a substance known as " Wassermann body " must also be noted as one of the early symptoms of syphilis. Just what this substance really is we do not know, but it is probably of a lipoid character, and is certainly not a true syphilitic antibody. Its presence is recognized by means of the complement-fixation test bearing Wassermann's name (see Chapter XLIII).

Enlargement of Lymphatic Glands not anatomically connected with the Chancre.—The indolent enlargement which probably involves to some extent all the lymphatic nodes of the economy, and which becomes apparent to the touch in certain accessible regions about the sixth week from the appearance of the chancre, must not be confounded with the syphilitic buboes which develop in about a week in the group of nodes anatomically nearest to the chancre. This late lymphatic enlargement when characteristically developed is pathognomonic of syphilis. While probably all the lymphatic nodes are involved, those in the post-cervical regions and the epitrochlear node, lying above and in front of the internal condyle of the humerus, are most prone to exhibit the indolent cartilaginous, painless, non-inflammatory enlargement so characteristic of developing secondary syphilis. The submaxillary, the anterior cervical group, the axillary, in fact, all the superficial nodes, may show the specific induration, but rare in so characteristic a manner as those in the two regions named. The tumors formed vary from the size of a pea to a chestnut.

The post-cervical chain passing downward from the occipital bone along the outer edge of the trapezius muscle is, in cleanly people at least, rarely enlarged from causes other than syphilis; thus painless, hard, indolent infiltration of these nodes would be far stronger evidence of specific disease than a similar condition noted in the sub-maxillary and anterior cervical group, which, owing to the presence of catarrhal and inflammatory affections of the throat from which they receive lymph, are found enlarged in perhaps the majority of people. For a similar reason characteristically enlarged epithrochlear nodes—that is, those above and in front of the internal condyle—constitute presumptive evidence of syphilis.

In syphilitic lymphatic nodes the follicles of the delicate reticulated tissues are hypertrophied, and give rise to small lobulated projections upon the surface when the capsule is removed. The lymph-spaces exhibit a cellular infiltration, and the fibrous tissues separating the alveoli are thickened. Frequently these nodes remain more or less hypertrophied not only during the period of secondary lesions, but also long after the syphilides have disappeared.

Although there is no clearly established relation between the extent of the lymphatic lesion and the severity of other secondary symptoms of syphilis, early and well-marked lymphatic involvement frequently has been noted in attacks of more than usual severity.

Syphilitic Fever.—About the time of lymphatic enlargement, and coincident with the earliest eruption, or preceding it, fever develops, associated with pallor, weakness, general malaise, headache, coated tongue, anorexia, and muscular or arthritic pains. The temperature rarely rises above 102° F., and the pulse is not markedly affected. In many patients the fever is either absent or so slightly marked that it is not noticed. It rarely becomes so severe as

to oblige the patient to keep to his bed. Exceptionally it assumes a malarial type, being characterized by irregular paroxysms of chills, fever, and sweat, but differs from malaria in the irregularity of the paroxysms and in the fact that quinine is utterly without effect in controlling it, while mercury is curative.

When the fever is continued and moderate in severity, and associated with depression of spirits, pallor, headache, and general debility, it may strongly suggest typhoid. If continued and of high grade, running to 104° or 105° F. and associated with evident osteocopic pains, it may lead to a suspicion of developing eruptive fever. If associated with an outbreak of pustular syphiloderm, such as exceptionally appears as an early skin lesion, the diagnosis from smallpox may be exceedingly difficult.

The involvement of the joints in early syphilis may, if associated with syphilitic fever, make the diagnosis of the latter from rheumatic fever a matter of impossibility till other symptoms of syphilis develop.

Diagnosis.—In making a diagnosis of syphilitic fever, the history of a preceding chancre, the presence of lymphatic enlargements are, of course, matters of prime importance. In addition to the history and the Wassermann reaction, it is to be noted that syphilitic fever is frequently associated with a clean tongue, good digestion, normal condition of the bowels, and an absence of the special diagnosistic features which characterize each of the fevers with which it may be confounded, as, for instance, the plasmodia and enlarged spleen of malaria, the tympany and spots of typhoid, and the crisis of variola.

It commonly subsides shortly after the appearance of the eruption. When it is continuous in type, is pronounced, and lasts for some time, the probability is that the attack of syphilis will be unusually severe and prolonged. In exceptional cases it does not appear till after the eruption has developed. It is mostly in women that the severe forms of continuous syphilitic fever are observed.

Syphilitic Neuralgia.—Coincidently with the syphilitic fever and constituting one of its symptoms, but also developing in the absence of evident fever, or sometimes preceding it, there may be dull pain, which is commonly neuralgic and shifting in character, and is felt mostly about the back of the neck, the back, and the shoulders, though it may be localized in any portion of the fibro-osseous system. This pain is most apt to be noticed at night; when continuous and severe there are usually nocturnal exacerbations. It occasionally attacks one or more joints, and may be accompanied by effusion and fixation; or it may assume a distinctly neuralgic type, simulating pleurodynia or other form of localized pain. Headaches, with nocturnal exacerbations, and sometimes associated with vertigo and nausea, point to meningeal congestion.

Frequently the pains are osteocopic (bone-breaking) in character, and are accompanied by marked tenderness over certain bones, particularly the middle third of the ribs and the lower third of the sternum. This is so often noted that some diagnostic value is given to the presence of pain on moderate pressure over these bones. These osteocopic pains are explained (Jullien) on the ground that the medulla of the bone takes part in the general lymphatic enlargement, thus occasioning pressure upon the nerves. Painful nodular swellings over

the frontal and parietal bones, or over the long bones, are also noted at times.

In doubtful cases rheumatoid, neuralgic, and osteocopic pains, either singly or associated, are of great value in deciding for or against the presence of syphilis. In some instances lymphatic enlargement and syphilitic pains may be the only symptoms which develop, fever being absent.

Among the symptoms which exceptionally precede alopecia and the secondary eruption, jaundice, albuminuria, ravenous appetite or bulimia, alteration in the sensibility of the skin, exaggerated reflexes, and enlargement of the spleen have been observed.

Syphilitic Eruptions of the Skin and the Mucous Membranes.—The syphilides, or eruptions of the skin, commonly appear a few days after the general lymphatic enlargement, though they are occasionally the first manifestations of constitutional disease. They are usually found about the forty-second day after the chancre. Exceptionally they have been seen within two weeks. On the other hand, they may not develop for four or five months, or in some few cases secondary syphilis may never appear, tertiary lesions first proving conclusively that a genital sore was a chancre. This is especially liable to be the case if mercury has been given before the appearance of secondary symptoms.

Cutaneous and mucous syphilides are more superficial in the early stages of the constitutional disease; as it grows older these lesions become deeper.

Thus the syphilides of the first period of secondary syphilis are due to a local hyperæmia and slight cell-infiltrate, affecting only the epidermic and papillary layers of the skin and producing erythematous, macular, and papular lesions. These heal without leaving scars. The older syphilides belonging to the late secondary and the tertiary period not only affect the epiderm and the papillary layer, but involve also the true derm and even the subdermic tissues, appearing as pustules and tubercles, which are often destructive and are followed by cicatrices.

These lesions are due to a cell-infiltrate much like that of granulation-tissue, except that it is not nearly so vascular.

The syphilides may, so far as the lesions are concerned, mimic with absolute fidelity many of the well-known skin diseases; there are, however, certain characteristics of the eruption, taken as a whole, which will generally make a correct diagnosis possible.

The general features of secondary syphilitic eruptions are as follows:

1. The lesions develop slowly, are painless, and do not itch.
2. They are rounded in form and grouping, and tend to scale.
3. They are of a copper or raw-ham color.
4. They are symmetrical.
5. They are polymorphous.
6. They are superficial.
7. They yield to specific treatment.

The later eruptions of the secondary period—that is, those occurring after the first year—and those of the intermediary and tertiary periods exhibit the following characteristics:

1. They are rounded in form and circinate in grouping. This is particularly well marked.

2. The lesions do not appear as a general eruption, but are grouped upon certain regions of the body.

3. They are deep, often involving the whole thickness of the skin and the subcutaneous tissue.

4. If dry, they are covered with a thin layer of gray, slightly adherent scales.

5. If ulcerating, they form punched-out, chronic ulcers, often covered with raised, thick, greenish-black, adherent crusts.

6. They are accompanied by very slight subjective symptoms.

When a general eruption first appearing on the chest and abdomen presents these features after full development, it can certainly be judged syphilitic in its nature. Frequently, however, the syphilide will depart in one or more points from the type to which it should theoretically correspond.

The absence of subjective symptoms—that is, freedom from pain and from itching—is a rule which has but few exceptions, if eruptions on the scalp and the hairy parts of the body are excluded. In these regions itching is very common. On the body and extremities the eruption is often not noted by the patient till the physician calls attention to it; or the patient becomes aware of it only because he has noticed it while dressing or bathing.

Exceptionally the itching is severe and harassing; this may arise from the specific eruption, but commonly it is found to be dependent upon an intercurrent condition, such as urticaria or prurigo or the presence of pediculi.

The rounded form and grouping of the syphilides are usually fairly well marked, though individual lesions widely depart from this type. The circinate grouping is much more pronounced in the late secondary and in the tertiary lesions; indeed, it is a striking feature of the eruption. In the early secondary lesions, particularly in roseola, this grouping is rarely so conspicuous as to be noticeable till it is carefully searched for.

The raw-ham or copper color of the eruption is not pronounced at first. The early erythema is usually a dusky red, though it may present the rosy-red hue of simple erythema. As the lesions develop, a certain amount of skin pigmentation takes place, the erythematous patches no longer disappearing entirely on pressure, but leaving a dark stain. The macules and papules become still more dusky, like raw ham, or even present a distinct coppery hue. This is fairly constant, but is not characteristic till the lesion has persisted at least some days. A similar coloration, together with absence of itching, is sometimes observed in the skin eruptions of gouty and rheumatic subjects. This pigmentation may last for years; usually it disappears in a few months. The epidermic layer of the skin suffers by reason of the interference with its nutrition caused by the cell-exudation in the papillary layer beneath it. Most syphilides, therefore, tend to become squamous.

The symmetrical development of the secondary syphilides is an almost constant feature of the eruption. The two corresponding sides of the body are usually invaded equally and by a somewhat similar form of the eruption. This tendency to symmetrical development is not observable in tertiary eruptions.

The polymorphism of secondary syphilides is at times the feature of most importance in establishing a correct diagnosis. This term implies that the lesion is many-formed; that is, while in one part of the body it is macular, in another

it is papular, in still another pustular, etc. The skin diseases which syphilis simulates usually conform to one type; that is, if certain lesions are observed in one part of the body, similar lesions, and no others, will be observed in other parts. This is not the case with syphilis, except at the beginning.

Usually the eruption develops gradually, first in the form of an erythema so slight as not to be noticed till the patient's skin is exposed to the air, when the eruption appears on the anterior and lateral aspects of the chest and belly as an exaggeration of that mottling which constantly occurs when a portion of the surface generally covered is suddenly chilled. This erythema becomes quite distinct in a few days. It persists and gradually shows the pigmentary changes; but in the meantime papules are developing in certain regions, or perhaps pustules or vesicles. The multiform eruption is due to the fact that the lesions persist, one variety not completing its course before another is developed.

The general eruption receives its name from the predominant lesion.

The superficial character of the early syphilides is due to the tendency of bacterial growth to occur in regions where the blood-current is slowed. The most marked efforts of the disease in this early secondary stage are, therefore, shown in the papillary layer of the skin, the epidermis becoming secondarily involved.

The Influence of Mercurial Treatment.—Although individual lesions may persist for months in spite of most careful medication, the usual effect of efficient mercurial treatment upon general secondary syphilitic eruptions is prompt and pronounced. Within a week the eruption is undergoing rapid resolution. This gives a means of diagnosis which in doubtful cases is exceedingly valuable.

Eruptions of the Mucous Membranes.—Involvement of the mucous membrane of the mouth is one of the most constant symptoms of constitutional syphilis. It often occurs even before the skin eruptions.

It may appear in the form of an acute erythema (acute syphilitic angina), involving the palate, half-arches, tonsils, and pharynx, accompanied by a marked œdema, closely resembling the non-specific sore throat, and generally ascribed to catching cold; more commonly it appears in the form of mucous patches. Indeed, these are the most constant lesions of secondary syphilis. They are commonly found on the tongue, the buccal mucous membrane, the half-arches, the tonsils, and the palate. Exceptionally they extend from the posterior half-arch to the pharyngeal mucous membrane. They appear as gray-white, irregularly shaped markings, not elevated above the surrounding healthy surface. The appearance presented by an individual lesion is very like that produced by brushing the mucous membrane with a stick of silver nitrate, except that the margins of the mucous patch are more sharply defined.

Together with the mucous patches there are often erosions and fissures of the tongue. The latter when deep and placed at the sides of the organ are painful, though the mouth eruption of secondary syphilis conforms to the general character of the disease in presenting few subjective symptoms. Contact with irritating or very hot foods may, however, cause pain.

Both the mucous patch and acute erythema also rarely develop in the urethra of the male, giving rise to a discharge which may simulate a mild

attack of gonorrhœa. In the female there may be acute erythema of the vagina; more commonly, indeed, in the majority of cases, mucous patches develop about the vaginal outlet.

Syphilitic Alopecia.—The impaired nutrition of the hair-follicles incident to constitutional syphilis causes the hair to lose its lustre and to come out in irregular patches. Usually the scalp and the eye-brows are alone affected. Sometimes all the hairy regions are involved, and there results complete denudation of the entire body.

The rapid onset of the baldness, the irregularity of distribution, and the fact that under constitutional treatment it is usually completely curable are characteristic features of the condition.

At times alopecia attacks the eyebrows alone, causing an irregular bald patch. This is so peculiar to syphilis that it is considered diagnostic (Fournier).

The alopecia which comes on later in the disease as a consequence of ulcerative lesions is due to atrophy of the hair-follicles, and is incurable.

Syphilitic onychia is dependent upon impaired nutrition of the nail matrix, and is commonly associated with the papular or pustular eruptions. The nails may become brittle and lustreless, or may be hypertrophied and deformed, or may exfoliate. These processes are associated at times with deep ulceration around the nails (perionychia).

Syphilitic Involvement of the Viscera.—At about the time the early constitutional symptoms, such as general lymphatic enlargement, fever, and syphilodermata, develop, there may be manifestations of the disturbing effect of the virus upon the viscera, though such signs, at least in their more serious forms, do not usually occur till late in the disease. The visceral symptoms which develop in early secondary syphilis are nearly always dependent upon an acute hyperæmia which, though caused by the syphilitic poison, differs in no way from similar conditions brought about by other causes, except in the fact that it yields promptly to specific treatment. Thus there may be temporary albuminuria from hyperæmia or inflammation of the kidney, violent cephalalgia from meningitis, pleural effusion from pleuritis.

In the early stage of secondary syphilis the liver may be hypertrophied. This may be accompanied either by pain or by jaundice, or by both of these symptoms. Jaundice does not appear as an isolated symptom of syphilis. Syphilides of the skin or of the mucous membrane are found associated with it.

It is more convenient to consider under tertiary syphilis the effects of the disease on the muscles, the bones, the nervous and vascular systems, and the viscera, since the secondary manifestations of the disease in these portions of the body are transitory and comparatively rare, and present only the ordinary symptoms of a more or less acute inflammation.

It is noteworthy that the symptoms in connection with the viscera become less acute in type as the attack of syphilis becomes older, and that when they develop they resemble the chronic rather than the acute form of inflammation, until finally in the tertiary period the formation of gummata takes place.

Syphilitic Disturbances of the Nervous System.—The commonest symptom of involvement of the nervous system in constitutional syphilis is the syphilitic neuralgia to which reference has already been made. This and the

other symptoms may be dependent upon the general cachexia, or more rarely may be due to pressure, as from enlarged lymphatics or swelling of the medulla or the periosteum of bones. The first and second branches of the trifacial nerve are especially subject to this form of syphilitic neuralgia.

Cephalalgia is common in the early secondary period. It is usually of moderate severity, is not a surface pain, but is located in the frontal or the occipital region of the brain, and is harassing rather than disabling; three are nocturnal exacerbations. Very exceptionally it becomes exceedingly severe.

Analgesia when present is found over the metacarpal region of each hand. It is an early, usually symmetrical lesion, and is not accompanied by anæsthesia, tactile sensation being retained. It may exceptionally take the form of thermo-analgesia or muscular analgesia.

Paralysis, particularly of the muscles of the eye and the face, is occasionally observed in early syphilis. It may involve single muscles or muscle groups, or may cause hemiplegia or paraplegia.

The nerve manifestations of secondary syphilis are usually short-lived and yield quickly to constitutional treatment.

Syphilitic involvement of the bones, joints, and tendinous sheaths is not rare in the secondary stage of the disease. The bones lying nearest the surface exhibit painful nodular swellings with the characteristic symptoms of acute periostitis. One or many joints may be the seat of more or less acute inflammation. Certain of the tendinous sheaths may develop the crackling and tenderness of tenosynovitis.

Iritis is the commonest eye manifestation of secondary syphilis; it may assume the plastic or the serous form. In either case the symptoms are like those of the inflammatory form of the disease, except that they are less acute.

Epididymitis occasionally develops as a lesion of early constitutional disease; it is unilateral, painless, and quickly subsides on treatment. Orchitis is rarely observed till the tertiary stage.

As a result of secondary syphilis, menstrual disturbances are very common: these may take any of the forms noted in debility from other causes. Both amenorrhœa and metrorrhagia have been observed. In the pregnant uterus abortion generally occurs.

SYPHILITIC SKIN ERUPTIONS

It should be remembered that recent syphilides (secondary) are superficial, while later eruptions (tertiary) are deep, but that typical tertiary eruptions may exceptionally appear in the secondary stage of the disease, or the secondary eruptions may appear late. The skin lesions of syphilis may be classed as follows:

1. Erythematous syphilides, called also erythema, macules, roseola.

2. Papular syphilides. In accordance with their size, shape, and surface, the papular syphilides are:

A. Conical or acuminated papular syphilides.

a. Large.

b. Small.

B. Flat or lenticular papular syphilides.
a. Large.
b. Small.
C. Moist papules (mucous patches).
D. Papulo-squamous syphilides.

3. Vesicular syphilides.
4. Pustular syphilides.
a. Small, acuminated pustular syphilides (miliary).
b. Large, acuminated pustular syphilides (acneiform).
c. Small, flat pustular syphilides (impetiginous).
d. Large, flat pustular syphilides (ecthymatous).
5. Pigmentary syphilides.
6. Bullous syphilides.
7. Tubercular syphilides.
8. Gummatous syphilides.

A pathological study of the secondary skin eruptions shows that they are made up of a small round-celled infiltration of the cutis and adnexa, together with the lower layers of the rete Malpighii. The blood-vessels are dilated, the endothelium is thickened, and there is a small-celled infiltrate of the adventitia. These changes involve the vessels of the papillæ, the Malpighian network, the hair-follicles, the sebaceous glands, and the sweat-glands. Whether the eruption be macular, papular, or pustular, the pathology is the same.

The pathology of the tertiary lesions differs from that of the secondary only in that the small-celled infiltrate is much more extensive, invading the entire thickness of the skin and the subcutaneous tissues. As a result, this mass of embryonal tissue, always poorly vascularized, degenerates centrally, and either ulcerates, discharging externally, or is partly absorbed and partly converted into fibrous tissue.

Grouping the skin lesions in accordance with the time of development, the eruptions of the secondary period are:

The erythematous syphilides (roseola); the papular and papulo-squamous syphilides (mucous patch, lichen, condyloma, psoriasis, etc.); the general pustular syphilides (acne, impetigo); the pigmentary syphilides; the bullous syphilides; the vesicular syphilides; the tubercular syphilides.

During the same time there may develop on the mucous membranes:

1. An acute erythema;
2. Mucous and scaly patches; or,
3. Superficial ulcerations.

With the exception of the pigmentary syphilide and the squamous form of the papular syphilide, these are general eruptions and appear during secondary syphilis in about the order given, the tubercular lesion being well on the borderline between the secondary and the tertiary period.

The syphilides of the tertiary stage are pustular and bullous syphilides, which appear discretely or in groups, and which ulcerate deeply (ecthyma, rupia), and gummata.

The mucous membrane manifestations of this stage are mucous and scaly patches and gummata.

Erythematous Syphilide.—This is the earliest and the most constant of all the skin lesions of syphilis. It appears about the same time that the general lymphatic enlargements become apparent. In the uncleanly and careless it

Fig. 376.—Erythematous syphilide. (From the collection of photographs of Dr. George Henry Fox.)

may run its course without attracting the attention of the patient. The eruption exhibits less of the rounded shape or grouping than any of the other syphilides.

It first appears as an irregular rose-red mottling of the surface, such as is constantly seen when covered surfaces are exposed to the cold. The lesion may not develop beyond this point, terminating promptly under treatment, or at times even without it, in a slight branny epithelial shedding. More commonly

FIG. 377.—Flat papular syphilide.

syphilitic roseola develops—that is, patches of varying size are formed, the smallest not larger than a pin-head, the largest the size of a quarter- or a half-dollar (Fig. 376). These patches are irregular in shape, frequently rounded or oval, but not necessarily so and shortly become raw-ham or even coppery in color. At first pressure of the finger and emptying of the superficial vessels

FIG. 378.—Acuminated papular syphilide. (From the collection of photographs of Dr. George Henry Fox.)

FIG. 379.—Acuminated papular syphilide. (From the collection of photographs of Dr. George Henry Fox.)

leave the skin white in the first days of the eruption, but later there is distinct pigmentation, the copper color remaining.

The eruption commonly appears on the sides and front of the belly and chest. It is also frequently observed on the back and on the flexor surfaces of the extremities. It is sometimes seen at the hair-line of the forehead and upon the palmar and plantar surfaces. It may, of course, develop on any surface of the body, but the regions just given are, in their order, those of preference.

The full erythematous eruption develops in about a week. Under treatment

FIG. 380.—Large flat papular syphilide. (From the collection of photographs of Dr. George Henry Fox.)

it rapidly disappears, even the pigment being absorbed and leaving no trace. If not treated, it lasts for weeks or months, and is accompanied by papular and pustular lesions, giving the eruption one of its characteristic features—polymorphism.

Diagnosis.—The diagnosis of the erythematous syphilide is much simplified by the presence of concomitant signs of the disease. At this stage the remains of a chancre are usually present, the enlarged lymph-nodes can be felt, and a history of rheumatoid pains, of sore throat, of headache, and of a slight feverish attack will be given.

Simple erythema and the copaiba rash may both simulate syphilitic roseola. Simple erythema, however, is not associated with a history of chancre or with the signs of early secondary syphilis, is more commonly accompanied by distinct fever and digestive disorder, itches, and develops and subsides in a short time, showing no tendency to persist and to become pigmented.

The copaiba rash often exhibits large itching confluent patches which run their course in a few days, which appear with special intensity in certain regions, such as the extensor surfaces of the joints, and which subside promptly on stop-

FIG. 381.—Large flat papular syphilide. (From the collection of photographs of Dr. George Henry Fox.)

ping the drug. There is a history of ingestion of copaiba, or, if this is denied, an examination of the urine will demonstrate the copaiba odor.

Measles is characterized by a history of exposure to the disease, Koplik's spots, high fever, cough, an eruption beginning on the face and becoming universal rapidly, and the pinkish-red, blotchy appearance of the macules.

PAPULAR SYPHILIDE.—The lesions of the papular syphiloderms appear as hard, small or large, acuminated or flat, smooth or scaling, rounded elevations, exhibiting a characteristic raw-ham or copper color. These lesions are due to

circumscribed hyperæmia, together with cellular infiltration of the papillary layer of the skin. They are frequently converted into vesicles or pustules.

The Small Papular Syphilide.—This eruption is usually an early manifestation of constitutional syphilis, exceptionally even preceding the roseola; frequently it does not develop till considerably after the fourth month. The papules may be conical, rounded, flat (lenticular), or umbilicated, and often exhibit a fine scaling. They vary in size from that of a pin-head to that of a split pea. At first rose-red, they become raw-ham or coppery in color. The lesions are apt to exhibit a circinate grouping, appearing as segments of circles, as complete circles, or in figures of eight. The eruption is usually well marked and involves a large surface (Fig. 377).

Fig. 382.—Large flat papular syphilide.

The acuminated (miliary) form is first noticed on the face. It subsequently appears on the trunk and the extremities.

The flat, lenticular, lichen-like form appears first about the shoulders, but the face, body, and extremities are soon involved, the lesions being particularly abundant about the flexures of the joints. The palmar and plantar surfaces also suffer. The eruption is somewhat chronic in its course, and is more resistant to treatment than the erythema. It is subject to relapses.

The Large Papular Syphilide.—As in the smaller lesions, these papules may be conical or flat.

The large conical papules are usually discrete, few in number, are found associated with the small papules, and are most abundant on the back, the buttocks, the back of the neck, the face, and the extensor surface of the thighs (Figs. 378 and 379).

The large, flat papules vary in size from that of a shirt-button to that of a penny (Figs. 380, 381, and 382). They are sharply circumscribed, elevated, and commonly exhibit a branny scaling. The eruption may be widely distributed or may be grouped in certain regions. Thus, the lesions are frequently found on the back, the nape of the neck, the forehead, the flexor surfaces of the extremities, and the scrotum, and about the mucous outlets (Fig. 383). Sometimes the lesions become fissured, and may give rise to severe pain. This is especially apt to occur on the hands and feet and about the mouth and the anus.

Mucous Patch.—When the papular syphilide develops on surfaces of the body which are kept constantly moist by secretions, or which are subject to

moisture and friction, as on mucous surfaces at the angles of the mouth (Fig. 384), beneath the dependent mammary gland, about the anus (Fig. 385), and the vulva (Fig. 386), within the foreskin, on the scrotum, or between

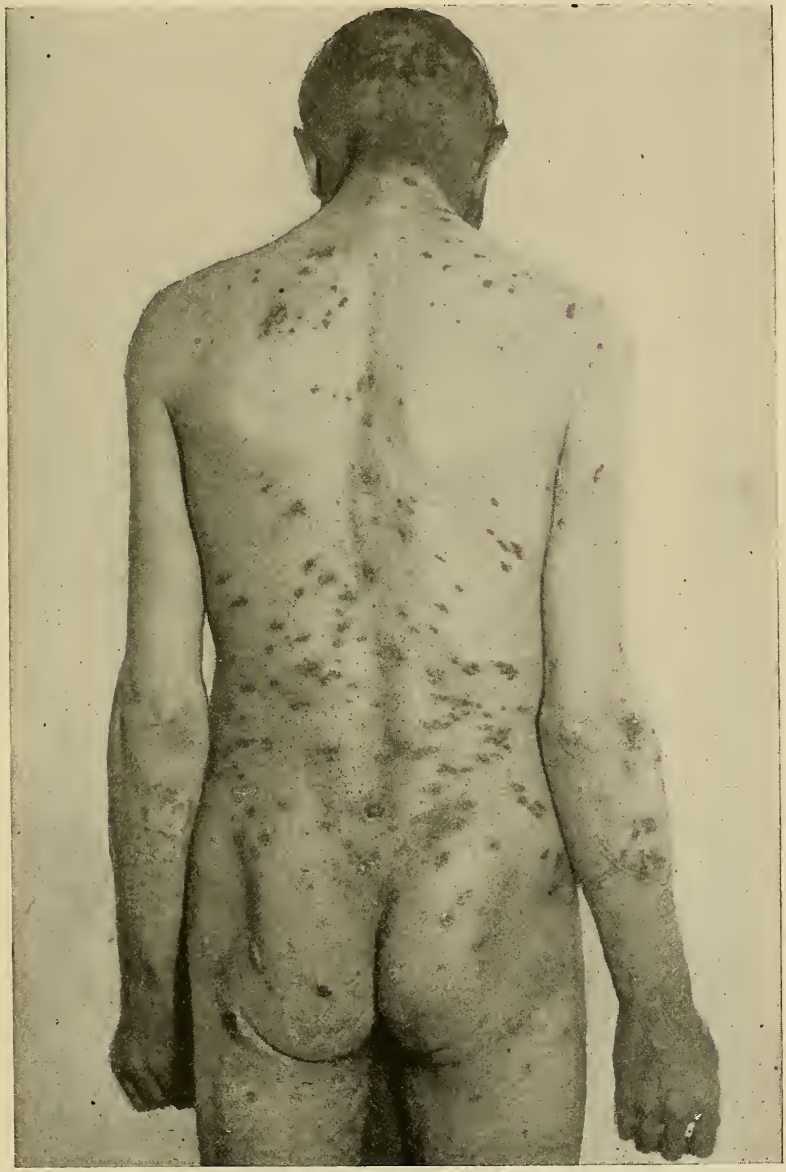


FIG. 383.—Large flat papular syphilide, showing scaling.

the toes, instead of the branny scaling which characterizes the dry lesion there is often abraded surface, which secretes freely and is partly or completely covered by a gray, adherent, offensive pseudo-membrane. The irritating secre-

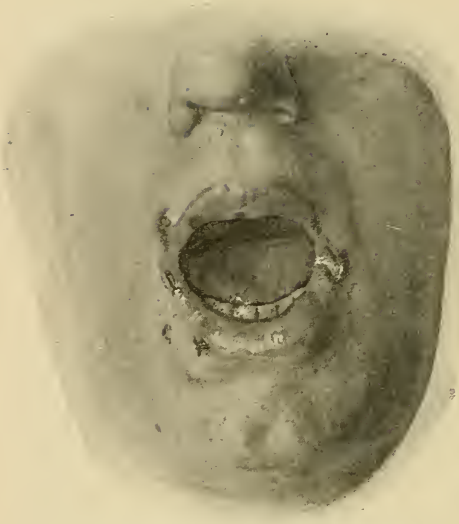


FIG. 384.—Mucous patches of the lips.

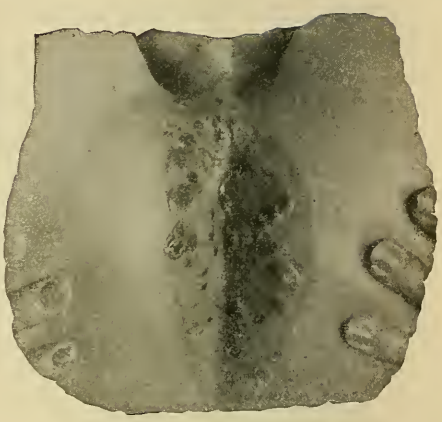


FIG. 385.—Mucous patches about the anus.

FIG. 386.—Vegetations and mucous patches about the vulva.

tions of these mucous patches frequently give rise to warty growths in the immediate environment. Sometimes the moist papule exhibits, in addition to hyperæmia, cell infiltration and abrasion, or superficial ulceration, a distinct papillary overgrowth, forming small or large papillomata (Fig. 387). These are properly termed condylomata, and should be distinguished from the mucous patch in which hypertrophy of the papillæ either is not present or is not marked. Commonly these condylomata appear as raised flat, raw surfaces, the cellular infiltration being so abundant that the papillary nature of the growth is but imperfectly marked. Occasionally large cauliflower-like warty growths

FIG. 387.—Papular syphilide, showing papillary overgrowth.

are formed, particularly in the regions of the face, scalp, shoulders, and genitals (Duhring). These are termed vegetating papules, and are often accompanied by abrasions and crusting of the surrounding skin (Fig. 388).

When subject to friction and not treated, the mucous patches may form ulcers. On the delicate skin of babies mucous patches frequently develop and are in them one of the commonest lesions of syphilis. In the adult they appear early, are prone to relapses, and may occur in the mouth even during the tertiary stage of syphilis. The secretions of the mucous patch are highly contagious.

Diagnosis of the Papular Syphilides.—The concomitant signs of syphilis,

such as the remains of a chancre, enlarged lymphatic nodes, sore throat, alopecia, scabs in the hair, etc., are usually present, and, in conjunction with the copper color of the eruption, its polymorphism, the absence of itching, and its grouping about the back, the neck, the forehead, the sides, and the buttocks, render the diagnosis of this syphilide easy.

When the large, flat, papular syphilides develop, either in the dry form or as mucous patches, the diagnosis can be made with certainty, since these lesions are absolutely characteristic of syphilis and are simulated by no skin disease.

Acne papulosum and lichen are both closely simulated by some forms of the papular syphilides.

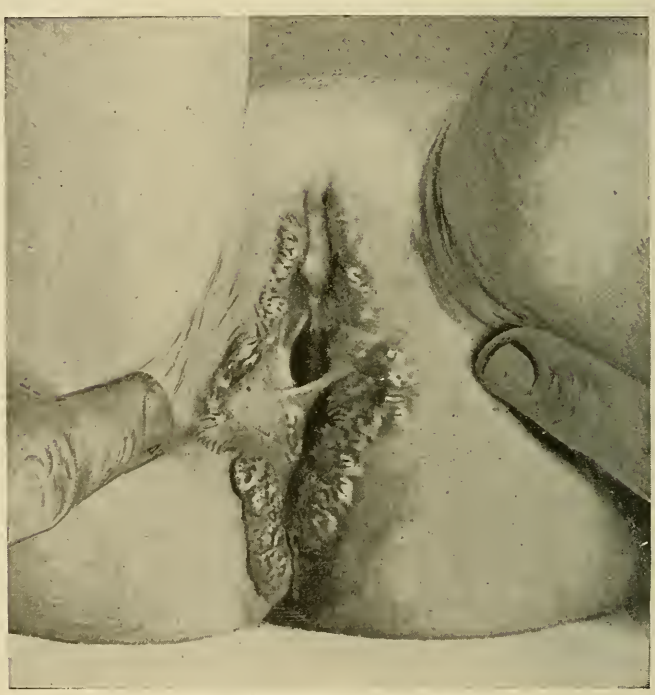


FIG. 388.—Syphilitic vegetations.

Acne papulosum is associated with none of the concomitant signs of syphilis, is found commonly about the forehead, cheeks, chin, shoulders, and back, leaves no pigmentation at the seat of cured lesions, and is often accompanied by pustules; or there may be scars resulting from the healing of the latter. When papular acne develops only on the forehead, the diagnosis must be formed mainly on the absence of other signs of syphilis.

Lichen may be acuminate or flat, and may be widely distributed. The lesions of this disease are dusky in color and occasion pigmentation of the skin. The individual papules are, however, angular in outline rather than rounded, and in place of a circular grouping are often arranged in rows or

FIG. 389.—Papulo-squamous syphilide. (From the collection of photographs of Dr. George Henry Fox.)

lines. They usually itch, and are not associated with any of the signs of syphilis. The eruption, however diffuse it may be, is papular throughout.

Keratosis pilaris, the conical elevations seated about the apertures of the hair-follicles and mostly found on the extensor surfaces of the thighs and arms and on the forearms, is sometimes mistaken for the small miliary syphilide. The absence of circular grouping, the distribution of the lesion, the uniform appearance presented by it, and the fact that each papule is invariably placed at the aperture of a hair follicle, will, in the absence of other signs of syphilis, render diagnosis easy.

Prognosis.—Papular syphilides yield to treatment, leaving a brownish pigmentation, which ultimately disappears. The effect of mercury is not so immediate as in the case of roseola. Still, in a few weeks a general papular eruption usually fades completely under constitutional treatment. The recurrent forms are somewhat more obstinate. These are prone to appear in circinate groups.

FIG. 390.—Gummata of cheek and nose.

PAPULAR-SQUAMOUS SYPHILIDES.—There is more or less desquamation with all the papular syphilides, but in some cases this may be so marked as to give the disease a distinctly squamous type. The lesions in this form of syphiloderm are generally flat, and are covered with fine gray scales, which are not very tightly adherent. As these scales are brushed away, the coppery, glistening surface of the papule is exposed, surrounded with a fairly well-marked collar of ragged epithelium.

These lesions when they appear early may be multiple and general, the patches varying in size as do those of papular syphilis (Fig. 389 and Plate XV). They may remain weeks or months without increasing in size, and commonly exhibit a distinct circinate arrangement of the individual papules of a group.

The well-marked papulo-squamous syphilides usually appear after the sixth month, and may develop in any subsequent period of the disease. The distribution of this lesion is similar to that of the papular syphilide.

On the palms and soles these papulo-squamous eruptions are most frequent and most resistant (Fig. 392 and Plate XVI). In the early period of the disease they are symmetrical; later this feature is not noted.

PLATE XV.

Courtesy, Dr. M. B. Hartzell

Papulo-squamous syphilide.

PLATE XVI.

Courtesy, Dr. M. B. Hartzell

Papulo-squamous syphilide of the hand.

Instead of the familiar macule with glistening coppery centre and gray epithelial scales about the edges, there may be a marked overgrowth of the corneous layer of the skin, forming hard conical projections in size from that of a pin-head to that of a pea. These can be dug out from the skin, leaving deep pits or depressions. They are most frequently noted on the soles, and are

FIG. 391.—Papulo-squamous syphilide. (From the collection of photographs of Dr. George Henry Fox.)

liable to occasion pain on walking. The papulo-squamous syphilides of the palms and soles are often complicated by painful and obstinate fissures.

These lesions may appear in the third month, or much later. They are prone to relapse, beginning about the centre of the palm and extending peripherally, forming lesions of circinate or serpiginous shape.

FIG. 392.—Papulo-squamous syphilide of the hand. (From the collection of photographs of Dr. George Henry Fox.)

Papulo-squamous eruption of the palms or soles alone, accompanied by but slight subjective symptoms, is almost pathognomonic of syphilis. Exceptionally the palmar syphilide appears as a diffuse exfoliation of fine epithelial scales, giving the surface a silvery aspect.

Diagnosis.—Papulo-squamous syphilides must be distinguished from psoriasis and from palmar eczema.

Psoriasis is entirely superficial, exhibiting but slight thickening, is not polymorphous, frequently appears before the twentieth year, its individual lesions are not markedly raised above the level of the surrounding surface, it is covered with a thick, imbricated skin, made up of white scales, is generally symmetrical (the late syphilitic papulo-squamous eruption does not usually exhibit this feature), is rarely confined to the palms and the soles, being commonly associated with similar lesions grouped about the extensor surfaces of the knees and the elbows, is always dry, is extremely chronic, is subject to relapses and obstinate to treatment, is not influenced by mercury, and primarily is not associated with other signs or symptoms of syphilis.

Eczema of the palms is attended with discharge, crusting, and itching; it begins about the wrist first, and not in the centre of the palm, and is not as sharply outlined as the specific lesion. When palmar or plantar syphilides become fissured or eroded they cannot be distinguished from eczema. Their reaction to specific treatment is so slow that the therapeutic test is of little service.

The circinate form of papulo-squamous syphiloderm may closely resemble the lesion of tinea circinata; the latter is, however, progressive, and microscopic examination shows the parasite.

Prognosis.—The lesions are obstinate, but ultimately heal; they may leave permanent scarring. Their pigmentation disappears.

Vesicular Syphilide.—This eruption is exceedingly rare. It may closely simulate, so far as the skin lesions are concerned, almost any of the non-specific vesicular diseases. Thus there are the eczematous form, the varicelloid form, and the herpetic form.

The vesicles may be small or large, may be generalized, or may come out in groups in certain regions of the body. They are prone to appear about the hair-follicles. They are observed on the face, the trunk, and the extremities. If there are seats of preference, these are perhaps the face, genitalia, forearms, and legs.

The eczematous form appears as a general eruption of small vesicles, either discrete or in patches, and generally sparing the face. When the vesicles are discrete, each is surrounded by a characteristic raw-ham-colored areola. If the fluid of the vesicles remains clear, it may break through its thin epidermic wall and escape, or may be reabsorbed, leaving only a slight epidermic exfoliation and temporary pigmentation; frequently, however, pustulation takes place, and thin yellow crusts are formed (impetigo). This last form is prone to appear on the face and about the genitalia, and is usually associated with papular and pustular lesions on other parts of the body.

The diagnosis from vesicular eczema will be made by the characteristic areola, the absence of itching and of acute inflammatory signs, the influence of mercury, and the presence of associated signs of syphilis.

The varicelloid form appears as large, not very numerous, discrete, split-pea-sized vesicles, either globular or umbilicated, which persist for some time, and then rupture, leaving an area of slight crusting and pigmentation. Or they may pustulate (presenting the appearance of varioloid) and crust. The base of each vesicle is surrounded by a characteristic copper-colored areola,

and other syphilides are usually present. Were the patient suffering from a well-marked fever, the syphilitic eruption might readily be taken for either varicella or varioloid, according to its type. A history of the case, and the concomitant signs of constitutional syphilis, should quickly establish the proper diagnosis.

The herpetic form of the vesicular syphilide exhibits clusters of vesicles of various sizes, either irregularly grouped or having a distinct circinate arrangement.

The lesions of the circinate form are small, are not persistent, dry up without rupture, and leave an area of superficial exfoliation and raw-ham-colored staining.

The diagnosis from ordinary herpes is generally made without trouble. Yet at times the syphilitic nature of the eruption can be determined only by the associated signs of syphilis. Although syphilitic vesicles as such do not persist for any great length of time, the copper-colored macules or pustules left after the absorption or rupture of the vesicles are liable to remain for many months.

Treatment.—The systemic treatment should be supplemented by mercurial baths to prevent the vesicles from becoming converted into pustules.

Pustular Syphilide.—The syphilitic pustule may be small or large, and either of these varieties may be acuminate or flat.

The lesions are commonly placed on indurated copper-colored bases; they may be surrounded by an extensive dusky areola.

In the early eruptions, and when the lesion first appears, the pus is contained between the raised epiderm and the true skin; later, deeper ulcers may be formed.

These syphilides very closely simulate any of the pustular nonspecific skin eruptions. They are prone to crust, the crusts varying from a dark-yellow to a dark-green or brown-black color, and exhibiting, when raised from the surface of the lesion, a distinct punched-out ulcer covered with viscid pus.

When the pustular lesions heal, they leave marked pigmentation, and, unless the ulceration is purely superficial, permanent cicatrices.

Pustules commonly appear late in the disease; their early development is usually associated with a severe form of syphilis.

The pustular syphilides may develop on any skin surface; if the lesions are few in number they are perhaps more frequently noted on the face, the scalp, and the legs.

Any of the syphilides may be found associated with pustular lesions, and even when the predominant eruption is papular the pustule may be found at the same time in all its forms and at all stages of evolution. An early pustular eruption is especially liable to be preceded by syphilitic fever of an intermittent type, with its associated symptoms of malaise, pallor, inability to concentrate the thoughts, headache, insomnia, articular pains, and sternal tenderness.

The pustular syphilides are somewhat obstinate to treatment, are prone to recur, and are more frequently followed by tertiary manifestations than when the eruption appears in a macular or a papular form (Bassereau). When

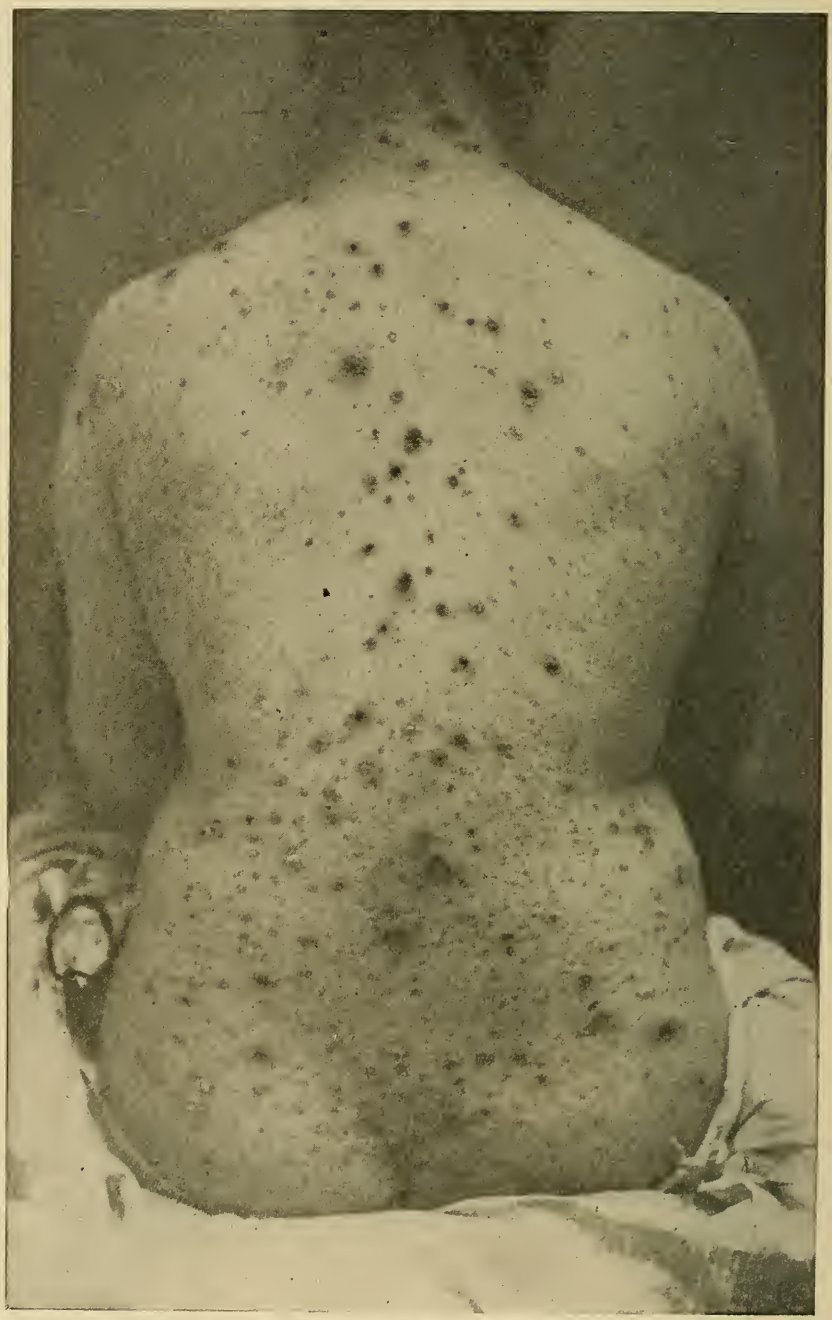


FIG. 393.—Large pustular syphilide. (From the collection of photographs of Dr. George Henry Fox.)

pustulation has been unusually well marked during the secondary stages of the disease the tubercular and gummatous lesions of the tertiary stage of the disease exhibit a marked tendency to suppurate.

Small Acuminate Pustular Syphilide.—This eruption is the most superficial, and usually in its time of appearance the earliest, eruption of this group. It is made up of minute miliary pustules, each situated about a hair-follicle or the opening of a sebaceous gland. It is followed by the formation of small yellowish crusts, leaving a pigmented spot surrounded by a fringe of exfoliating epithelium. On its first appearance the eruption usually covers a large surface, may be discrete or confluent, and exhibits circinate grouping. Relapses of this syphilide are not apt to appear as a general eruption, but rather the lesions will be grouped in certain localities.

When the lesions become confluent, superficial scabs are formed very like those observed in impetigo. The eruption about the lips is sometimes accompanied by a warty growth. This eruption corresponds closely to the small vesicular syphilide, the only difference being that the raised epidermis has beneath it pus instead of serum.

This pustular syphilide does not last long. Slight crusting takes place, and a pigmented spot is left which is slow to disappear. Sometimes, and this is particularly true of the relapses, ulceration takes place and a permanent cicatrix is left.

Diagnosis.—The diagnosis is founded upon the pigmentation, and is usually rendered easy by the fact that this eruption very rarely appears alone, being commonly associated with papules and roseola.

Large Acuminate Pustular Syphilide (Fig. 393).—This eruption may develop suddenly, or may form slowly with fever. When the pustules are moderate in size, they so closely resemble ordinary acne that the term syphilitic acne is very generally employed to designate them. The individual lesion begins as a macule, which quickly becomes converted into a papule, then a pustule, commonly placed about a hair-follicle, upon a papular, infiltrated, copper-colored base. The pustule remains for one or two weeks before rupturing. Then crusts are formed, which in dropping off expose either a superficial ulcer or, more commonly, a coppery papule. This and the pigmentation very slowly disappear; usually there is scarring.

Syphilitic acne may appear as a general eruption; more commonly it invades the scalp, face, and trunk; it is often found on the limbs.

Diagnosis.—The diagnosis of the large acuminate pustular syphilide will be founded mainly on the presence of other signs of syphilis, particularly the other syphilides. Ordinary acne commonly appears on the face, chest, and back, about the age of puberty, being rare in late life, and on the removal of the crusts does not exhibit the coppery, lenticular papule of syphilis. An acne-like eruption confined to the trunk and the legs strongly suggests syphilis.

Variola is a uniform eruption, the lesions all corresponding to the papular, then to the pustular type. It is acute, follows definite, well-marked prodromes, runs its course in a few days, and is attended with very pronounced constitutional symptoms. The dorsal surfaces of the wrists and hands and the palms and soles are nearly always affected with papules, followed by pustules, and

this disease occurs only in those not protected by vaccination. There is little danger of mistaking this eruption for a pustular syphiloderm. An error the reverse of this has been made many times, syphilitic patients having been sent to small-pox hospitals. A diagnosis can be made at times only after one or two days' observation.

Small, Flat Pustular Syphilide.—The lesions of this form of syphilide closely resemble those of impetigo. They are more common than the acuminate syphilides. Small, flat, split-pea-sized pustules form on somewhat elevated copper-colored bases. These pustules shortly rupture, and are followed by rather thick, adherent, yellowish or greenish crusts. These lesions may be discrete, may exhibit a circinate grouping, or may be confluent, forming irregularly shaped crusts (pustulo-crustaceous) Plate XVII). In the later periods of the disease this eruption commonly appears in the form of irregular patches, often presenting a narrow crusted circinate border, which, spreading peripherally, encloses an area of pigmented, scarred, or normal skin (Fig. 394).

FIG. 394.—Pustular syphilide (pustulo-crustaceous). (From the collection of photographs of Dr. George Henry Fox.)

Beneath the crusts of syphilitic impetigo are found ulcers. These may be superficial or deep, the latter variety appearing late in the disease. These ulcers on healing leave depressed, pigmented cicatrices, which are prone to scale for months. The pigmentation finally fades, the scar remaining white.

When syphilitic impetigo appears as an early general eruption, it may last but a few weeks. The late confluent circinate and serpiginous forms are extremely chronic.

The favorite seat is the face, especially in the hairy portions, as the beard and the eyebrows, and about the nostrils and lips (Figs. 395 and 396). They also develop frequently on the scalp (Fig. 397), the chest, and the outer surfaces of the arms and legs (Fig. 398).

Diagnosis.—The diagnosis of small, flat pustular syphiloderm is sometimes not possible from the inspection of the lesions alone, the latter corresponding very closely to those of pustular eczema and impetigo.

The crusts of pustular eczema on being raised show an excoriation, and the disease is distinctly more inflammatory in type than the syphiloderm. The

PLATE XVII.

Pustulo-crustaceous syphilide. (Fox.)

pustule of impetigo is discrete, not placed on an infiltrated base, and exhibits no copper-colored areola.

It is mainly by the presence or the absence of associated signs of syphilis that a diagnosis is to be made.

Large, Flat Pustular Syphilide.—The lesions of this syphilide closely resemble ecthyma; hence the eruption is commonly called syphilitic ecthyma. It appears in the form of large, flat pustules, varying from a quarter of an inch to an inch and a half in diameter (Fig. 399). The lesion commonly

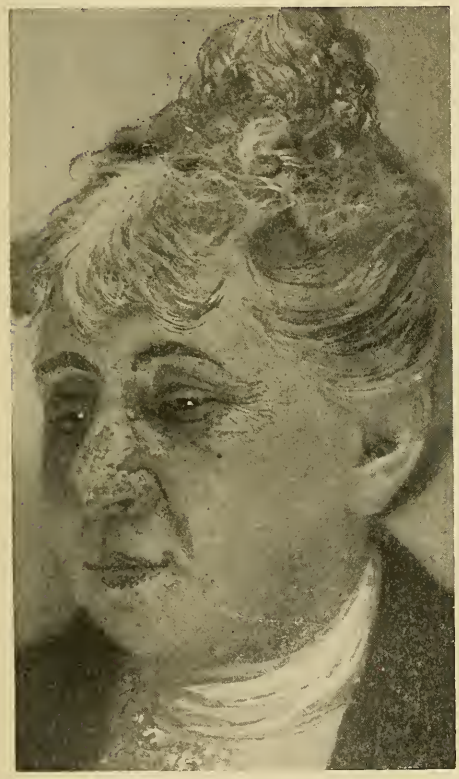


FIG. 395.

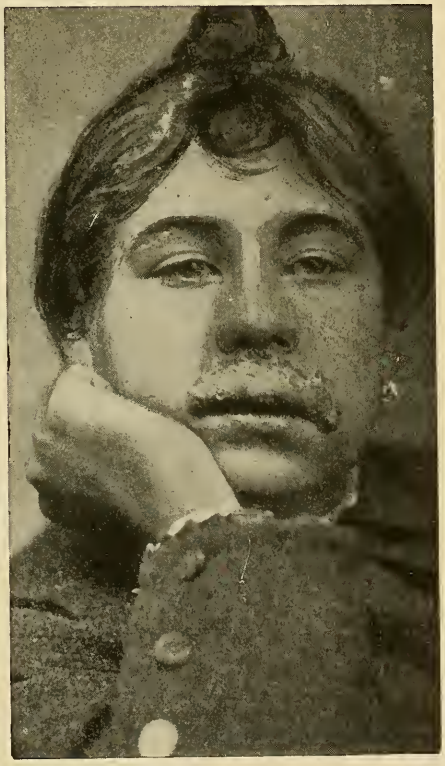


FIG. 396.

Pustular syphilide (pustulo-crustaceous). (From the collection of photographs of Dr. George Henry Fox.)

begins as a raised, dusky red, slightly inflamed, and indurated area, which quickly suppurates, the pus raising the epiderm but slightly, and forming a large, flat, not very tense pustule, which shortly crusts.

The lesion may remain superficial, limited, and only moderately crusted, exposing, on exfoliation or removal of the scab, an erosion or a shallow ulceration, or it may extend both in depth and in circumference.

The superficial form occurs towards the end of the first year of constitutional syphilis; it is amenable to treatment, and particularly affects the shoulders, back, and extremities.

In the deep form of syphilitic ecthyma the ulceration is progressive in all directions. The crust increases in thickness and extent, the material for it being furnished in the continued suppuration of the extending ulcer; it projects from the surface in the form of a greenish or brown-black cone, often exhibiting distinct stratification. This thick, conical, adherent crust commonly overlaps the raw surface beneath; sometimes its base is sunk in the ulcer and is completely surrounded by unhealthy granulations.

Lesions made up of these dark, raised, conical, laminated crusts, seated upon deep ulcers, and surrounded by reddened, indurated areas, are called rupial. When the ulceration extends laterally and does not grow materially deeper, the crust may be depressed in the centre and elevated about the margins.

Fig. 397.—Pustular syphilide. (From the collection of photographs of Dr. George Henry Fox.)

When the thick crusts of deep ecthyma are removed, punched-out ulcers covered with thick greenish or yellow pus are found. These ulcers are rounded or circular, and usually discrete and few in number. When the pustules are closely grouped they commonly become confluent, the outline of the resultant lesion being circinate.

The chronic crusted lesions of the pustular syphilides are termed pustulocrustaceous. When they are confluent, spreading widely in circinate forms, and are destructive, they are termed serpiginous (Fig. 400).

Diagnosis.—The diagnosis of syphilitic ecthyma from simple ecthyma will be based largely upon the evolution of the lesions, which in non-specific disease develop rapidly and run their course in a few weeks, are attended with

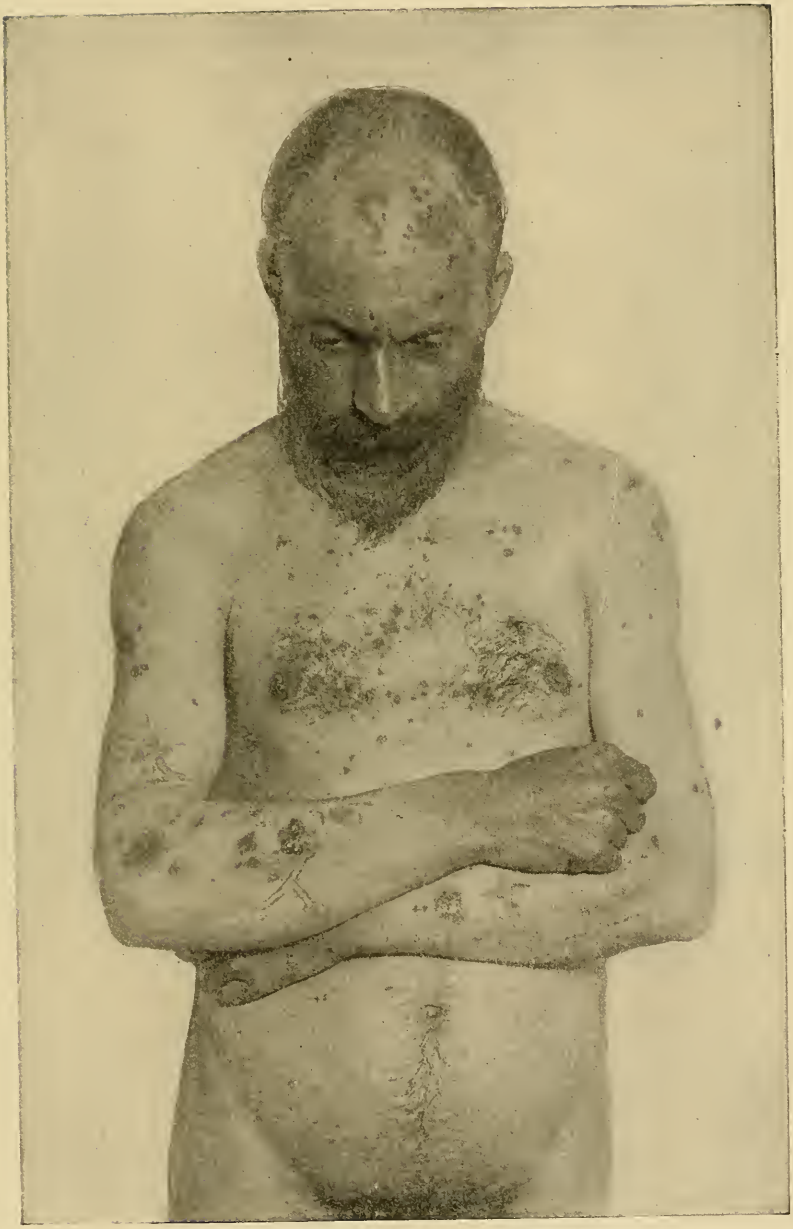


FIG. 398.—Flat pustular and papulo-squamous syphilide.

heat, pain, and other symptoms of acute inflammation, form brownish, not very thick, laminated crusts, and exhibit on removal of the latter superficial ulceration in place of the punched-out unhealthy ulcer of syphilis. In ecthyma the eruption is uniform, and there are no coexistent signs of syphilis.

Deep ecthyma leaves permanent cicatrices. Rupial and the other forms of deep syphilitic ecthyma appear as late lesions of syphilis.

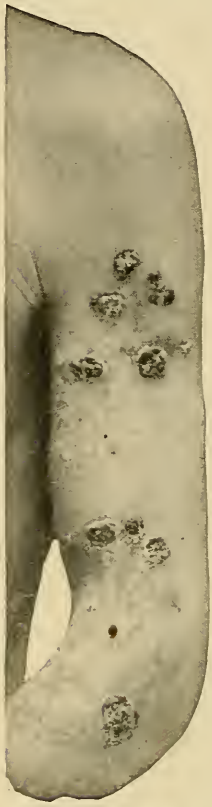


FIG. 399.—Large, flat pustular syphilide (ecthyma). (From the collection of photographs of Dr. George Henry Fox.)

FIG. 400.—Serpiginous syphilide. (From the collection of photographs of Dr. George Henry Fox.)

All the late pustular eruptions, particularly those which are deep, yield to specific treatment slowly. They usually develop in the cachectic and poorly nourished, and indicate tonic supporting treatment in addition to specific medication and local applications.

PIGMENTARY SYPHILIDE.—The pigmentary syphilides are quite distinct from the stains secondary to the papular or pustular eruption of syphilis. They are dependent upon a primary excess of pigment, which may subsequently give place to leucoderma, or loss of color. The lesion appears in three forms (Taylor):

1. As rounded, oval, or irregular plaques, with sharply defined or jagged borders, varying from light brown to deep brown.

2. As diffuse pigmentation, which becomes the seat of leucodermatous changes, appearing first as small spots, which gradually increase in size (retiform pigmentation).

3. As abnormal distribution of pigment, some parts of the skin appearing lighter, others darker, than normal (marbled pigmentation).

The pigmentation is unaffected by pressure, the patches are not above the surface of the surrounding skin, and there is no exfoliation. It is usually a secondary manifestation of the disease, developing about the sixth month, though it is at times observed as late as the second or the third year. It is more common in females before middle age. Its seats of preference are the sides of the neck, though it may be found elsewhere, as the chest, the forehead, and the flexor surfaces of the limbs. It lasts for several months, then gradually fades, the skin resuming its natural color. Treatment seems to have no effect upon it.

Tubercular Syphilide.—Tubercular syphilides appear as pin-head- or almond-sized, rounded or flat, hard, copper-colored infiltrations, which invade

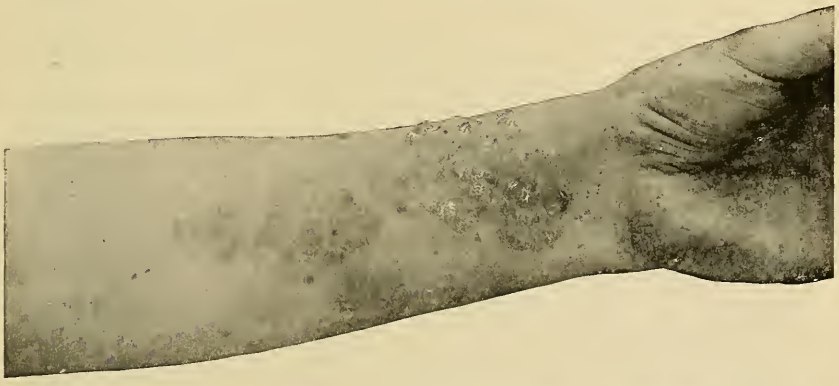


Fig. 401.—Non-ulcerating tubercular syphilide. (From the collection of photographs of Dr. George Henry Fox.)

the entire thickness of the skin, differing in this respect from the papular eruption, and resembling, except in the absence of acute inflammatory symptoms, a forming furuncle.

The eruption may be generalized, or may occur in patches on certain parts of the body; it may be discrete or confluent; it may be circinate, serpiginous, or irregularly grouped. It may ulcerate, or the infiltrate may become absorbed. In either case there is usually permanent scarring.

A discrete general eruption is rare; it occurs in the late secondary or in the tertiary period of the disease, rarely before the end of the first year, though exceptionally it may develop within six months of the chancre.

The eruption commonly appears grouped on one or more regions of the body, the indurated lesions having a tendency to coalesce and form circular, scaling, or, if ulceration takes place, eroding patches. Lesions of this kind

may develop twenty, thirty, or forty years after the appearance of a chancre (Bassereau).

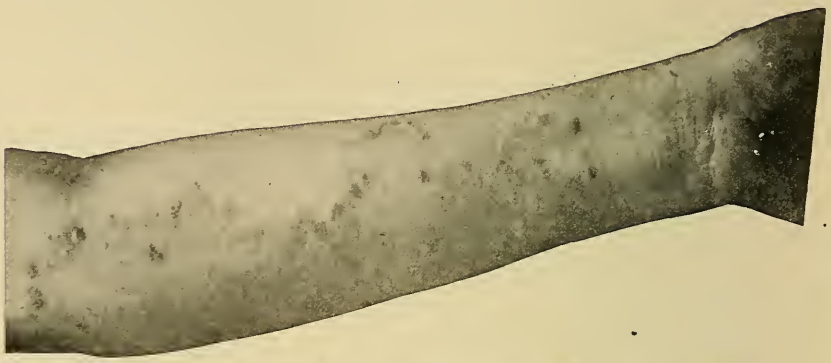


FIG. 402.—Non-ulcerating tubercular syphilide. (From the collection of photographs of Dr. George Henry Fox.)

FIG. 403.—Tubercular (squamous) syphilide. (From the collection of photographs of Dr. George Henry Fox.)

Though the tubercular syphilide may attack any portion of the skin surface, its seats of preference are the face, particularly about the lips and nose, the forehead, the ears, the back, and the legs. The course of this eruption is extremely chronic; it is prone to relapse.

The Non-Ulcerating Tubercular Syphilide.—The hard, dusky red,

chronic, scaling, tubercular eruption, when general and discrete, cannot well be confounded with any other lesion, except the papular syphilide; an error of no great moment, but one which is avoided by noting that the tubercle involves the entire thickness of the skin and appears at a later stage of the disease than does the papule. When grouped, the individual lesions of each group are usually much smaller than the lesions of the discrete general eruption; they tend to coalesce, forming circular or irregular patches (Fig. 401), which increase in size peripherally, while absorption and more or less atrophy

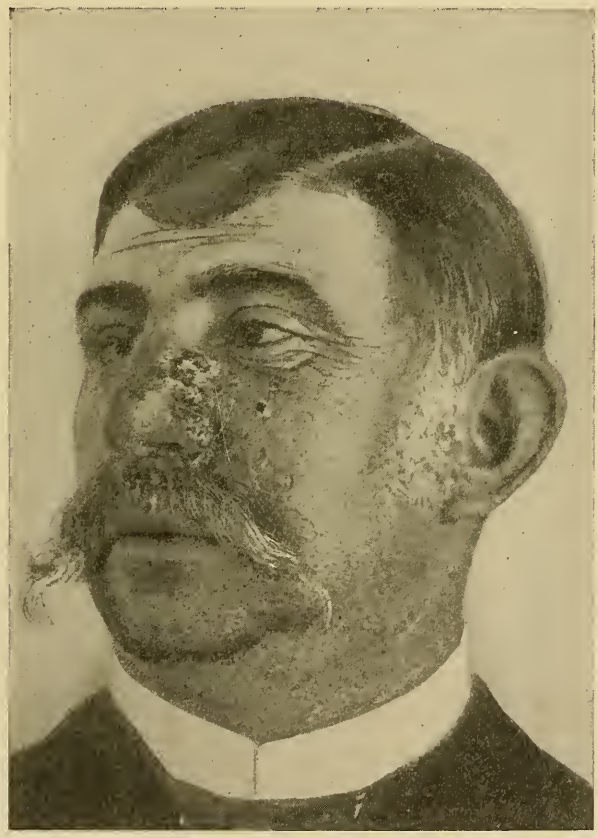


FIG. 404.—Tubercular syphilide. (From the collection of photographs of Dr. George Henry Fox.)

of the skin take place in the centre. This results in a raised circular margin made up of tubercles so merged that they can rarely be distinguished as separate tumors, within which lies the depressed, pigmented, atrophic skin (Fig. 402). These circles vary in diameter from a fraction of an inch to four or five inches. The surface of the non-ulcerating tubercle may be dry and glistening. More commonly there is a covering of branny scales (tuberculo-squamous syphilide) (Fig. 403). These lesions develop without subjective sensations, except when situated upon the face. After an

alcoholic debauch there may be marked local inflammatory phenomena in lesions thus situated.

The tubercles are resistant to treatment, often lasting for months. They may form permanent scars, incident to a process of interstitial absorption. These scars are at first brown or copper-colored; ultimately they become white.

Ulcerating tubercular syphilides are much more serious than the dry tubercular eruption, both in their immediate effects and from a prognostic

FIG. 405.—Tubercular syphilide. (From the collection of photographs of Dr. George Henry Fox.)

standpoint. The dry lesion after persisting for months may break down; more commonly the tubercle from the first shows a tendency to crust. This form of eruption is rarely general, commonly affects certain regions of the body, exhibits a round grouping, and may invade a large surface.

The ulceration may be superficial, attended by a slight scabbing and followed by very little scarring; or it may be deep, invading the entire thickness of the skin (Plate XVIII), may be covered by thick scabs (Fig. 404), and may be followed by dense cicatrices, which cause both disfigurement and disability.

PLATE XVIII.

Ulcerating tubercular syphilide.

The ulceration extends slowly, healing with the formation of scar-tissue in one place while breaking down is taking place in another. This process may continue for months or years, the diseased area forming circles, broad bands, or irregular figures (Fig. 405), and involving a large surface. Thus the entire face may be disfigured by the lesion. This form is called serpiginous. It is, of course, not exempt from the microbic invasion to which all open surfaces are exposed, and as a result of infection may become phagedænic, the ulceration extending with extreme rapidity and destroying a large amount of tissue in a few hours.

The face and back are the favorite seats of serpiginous syphilides.

As in other forms of syphilitic skin eruptions, in place of ulceration and destruction there may be hypertrophy, the skin papillæ growing from the ulcerated surface of a tubercle to form a pus-secreting cauliflower growth.

Frequently the cicatrices of ulcerating tubercular syphilides are pathognomonic of the specific lesions; in the midst of the large scars can be seen the small, depressed, round cicatrices of individual tubercles.

Diagnosis.—The diagnosis of the tubercular syphilide must be made from lupus vulgaris. Lepra and carcinoma are also closely simulated by this syphilide.

The main diagnostic points between ulcerating tubercular syphilide and lupus vulgaris are as follows:

Tubercular Syphilide.	*Lupus Vulgaris.*
Tubercular syphilide generally occurs in adults who give a history of syphilis or exhibit signs of other syphilitic lesions.	Lupus vulgaris generally occurs, or at least first appears, before the twentieth year of life, without history or signs of syphilis.
Begins as a copper-colored or brownish tubercle, which becomes a characteristic ulcer in one or two months.	Begins as a tubercle, which does not ulcerate to the same extent for many months or even years.
The tubercles are of a brownish-red or coppery color, and are comparatively large.	The tubercles are often translucent, of lighter color, and are small.
The skin is distinctly infiltrated through its entire thickness.	The infiltration of the skin is not so marked.
Ulcers, if distinct, are small, circular, punched out. If confluent, they involve a large area. The secretion may be copious and offensive.	Ulcers are rarely distinct. They are superficial, are not punched out, exhibit no regular form, and seldom involve large areas. The secretion is slight and not offensive.
The crusts are bulky and greenish or brownish black.	The crusts are thin and dark red.
The scabs are irregular in shape and attachment.	The scabs are arranged more regularly, attached in the centre, and loosened at the edges.
The scars are soft, white, and circular. Local treatment is ineffective. Internal specific treatment effects a cure.	The scars are distorted, irregular, and puckered. Active surgical intervention is effective. Internal specific treatment is without effect.

Aside from the history of the case, the most important points to be considered in differentiating between lupus and syphilis are the early age at which lupus begins, its very slow course, its superficial ulcerations, and its

cicatrices, which exhibit neither the characteristic coppery stains nor the many small, depressed, circular scars of ulcerating tubercular syphilides.

Cancer is sometimes closely simulated by the tubercular syphilide. The slow growth, the steady progress without attempt at cicatrization, the scanty discharge, the lancinating pains, the lymphatic involvement, the absence of signs or history of syphilis, and the resistance to specific treatment, are symptoms which will generally lead to a correct diagnosis.

The Bullous Syphilide.—This eruption usually appears as rounded or oval, discrete blebs surrounded by a slight areola, varying in size from that of a split pea to that of a penny. The clear serum contained within the bleb shortly becomes turbid and blood-stained or even distinctly purulent. On rupture of the blebs, the contents form dark-yellowish or greenish-black scabs. These, growing from the bottom, by the drying of the freshly secreted pus of the slowly enlarging ulcer, finally result in raised, conical, imbricated crusts, often half an inch to an inch in height, and sometimes twice as much in diameter (Fig. 406). These crusts are adherent, and usually overlap and conceal the underlying ulcer, though sometimes they may be set in the latter as a watch-crystal is set in its rim. Unless mechanically disturbed, they generally remain till the ulcer is healed. If they are removed, a deep, punched-out, unhealthy, granulating surface is exposed, covered with sanious pus.

The bullous syphiloderm is commonly found in broken-down subjects, and is significant of an inveterate form of syphilitic poisoning. The crusted ulcers following bullæ or pustules form the typical rupial lesions. The crusts of their rupia are large, and are thicker and darker than those of any of the other syphilides. The ulceration involves the entire thickness of the skin, and often extends over a large surface.

The scars left by rupia are similar to those of deep ecthyma. The eruption is encountered in the tertiary stage of the disease, and is one of the most characteristic lesions of syphilis.

The Gummatous Syphilide.—Though gummata of the skin exceptionally appear in the first six months of syphilis, in such cases indicating a grave form of the disease, they commonly develop three or four years after the chancre.

Gumma differs from the lesions already described in the fact that it is a true tumor or granuloma, which, having once developed, in whatever way it terminates permanently, affects the seat of invasion.

The favorite localities of the gummatous syphilides are the face (particularly the forehead), arms, forearms, the anterior surface of the leg (particularly the upper third), the skin overlying the sternum and clavicle, the scrotum, the penis, the external genitalia of women.

Gummata of the skin commonly appear as rounded, painless, subcutaneous nodules, freely movable, and varying in size from that of a pea to that of a cherry. These slowly grow, reddening, infiltrating, and softening the superficial layers of the skin and breaking down to form deep, undermined, slough-sloughing ulcers (Figs. 407, 408, and 409). Sometimes the gumma begins as a circumscribed infiltration of the skin instead of a distinct subcutaneous tumor.

FIG. 406.—Syphilitic rupia following the bullous syphilide.

The gumma goes through the stages of: 1. Formation, usually of long duration and unattended by pain. 2. Softening, fluctuation being felt when the tumor has reached its full size (from that of an almond to that of a hen's egg). 3. Ulceration; the skin becomes discolored and perforated, and a small quantity of puriform, gummy liquid is discharged. 4. Reparation; after extrusion of the slough granulations form, growing centrally from the periphery of the ulcer.

When the gumma opens there is at once an escape of mucilaginous liquid. The partially disorganized infiltrate adheres by its deeper portions to the subcutaneous cellular tissue, and is subsequently thrown off in the form of sloughs. By the process of ulceration a number of contiguous gummata may coalesce, forming one huge cavity, with irregular sloughing walls.

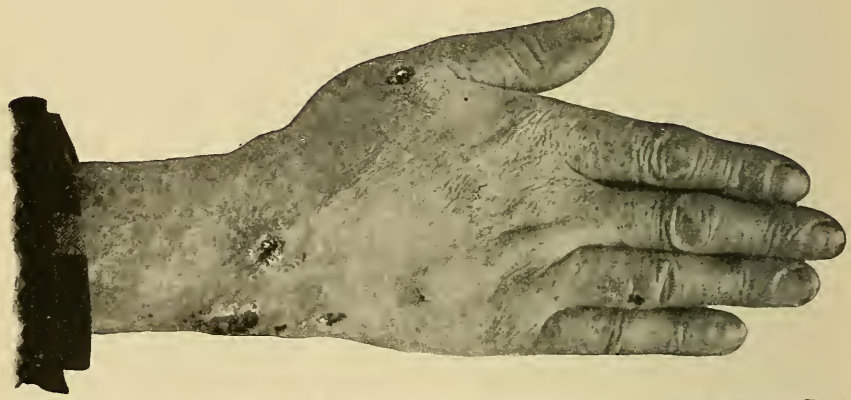


FIG. 407.—Gummatous syphilide. (From the collection of photographs of Dr. George Henry Fox.)

Though the stage of formation is slow and painless, the patient often noticing the tumor only by accident, softening and ulceration may progress with great rapidity. Thus, Bassereau states that a small, indolent, subcutaneous nodule of the nose or ear has in a single night undergone extensive destructive ulceration, producing permanent disfigurement.

The gumma may be single or multiple. In the latter case there are rarely more than half a dozen (Fig. 410). Exceptionally several dozen may develop, either simultaneously or following one another, usually showing a circular or circinate grouping and exhibiting a tendency to coalesce, forming a diffuse infiltration, which on ulceration may discharge by several openings through the blue undermined skin.

The middle of the forehead is a favorite seat of gummata. One or several nodules may develop. They commonly involve the underlying bone, producing caries, which may extend through its entire thickness, exposing the dura.

Exceptionally there develops a deep and diffuse infiltration of the face, causing a great thickening of the skin and presenting the appearance of leontiasis. Acute inflammation of this infiltrate is especially liable to occur in drunkards, and leads to extensive destruction of tissue and consequent deform-

ity, and exceptionally to violent hemorrhage from erosion of blood-vessels. These gummatous infiltrations are sometimes transformed to tuberculous or cancerous lesions.

Gummata of the extremities may be single or multiple. As they appear on the leg they are commonly multiple, and have for their seats of predilection

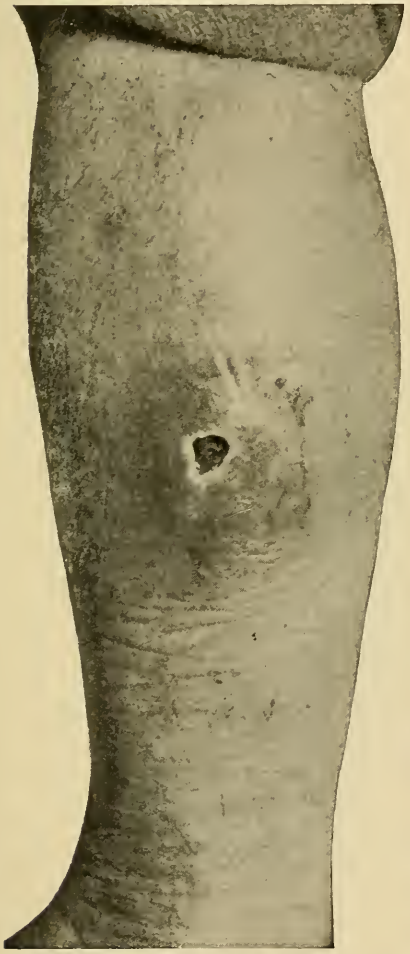


FIG. 408.—Single ulcerating gumma.

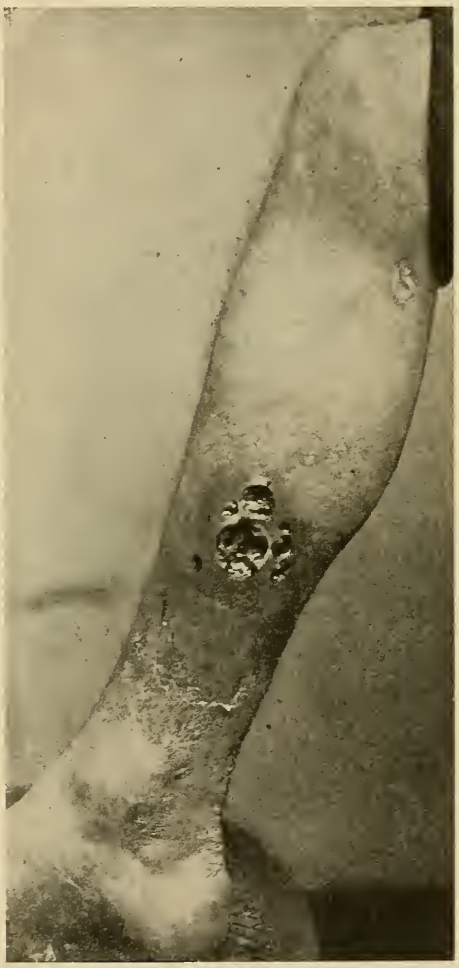


FIG. 409.—Ulcerating gummata becoming confluent. (From the collection of photographs of Dr. George Henry Fox.)

the anterior and lateral surfaces of the upper third and the malleolar regions. When placed here they break down readily and are subject to mixed infection (Fig. 411). They are extremely obstinate to treatment, and ultimately assume the chronic indurated appearance of ulcers due to other causes, particularly when they are near the malleoli (Fig. 412). Gummatous syphilides when they develop over the clavicle and sternum are often associated with

underlying periostitis and ostitis. Because of this, when they have ulcerated they are difficult to cure.

The prepuce may be affected by either diffuse gummatous infiltration or individual nodules. In either case the diagnosis from primary lesion can be made from the fact that infiltration preceded ulceration. Single ulcerating gummatous lesions of the glans penis may exactly simulate chancre. The inguinal lymph-nodes do not, however, share the characteristic enlargement of

FIG. 410.—Multiple gummata of the leg. (From the collection of photographs of Dr. George Henry Fox.)

the primary lesion, and the development of the lesion and the history of the case usually point to the true diagnosis.

The gummatous ulcer may become serpiginous or phagedænic. The necrosis involves not only the imperfectly organized, round-celled infiltrate of gumma, but also the anatomically associated tissues, often exposing and eroding bone, destroying tendons and muscles, opening mucous channels, and resulting in disfiguring and disabling cicatrices. In the scrofulous, gummatous ulcers are particularly persistent. Exceptionally these ulcers exhibit papillary outcrop-

pings presenting an appearance much like that of epithelioma. From the scars of these ulcers epitheliomata sometimes develop.

Diagnosis.—A history of syphilis, or concomitant signs of the disease, and the typical development of a painless infiltration at a seat of predilection, should establish the diagnosis of gumma. As this lesion is a late tertiary symptom, it may stand alone as an expression of the constitutional disease, since too often a clear history is wanting both of preceding syphilis and of the mode of onset of the gumma. When the tumor is seen during the stage of infiltration it may simulate benign tumor or sarcoma so closely that diagnosis can be made only by the therapeutic test or by keeping the growth under

FIG. 411.—Sloughing gumma of the leg.

observation a sufficient length of time to note its mode of development. The alleged cure of sarcoma by mercury clearly shows the difficulty in making a correct diagnosis from one examination.

When the gumma has ulcerated and exhibits papillary outgrowths it may resemble epithelioma almost exactly. The mode of onset is, however, different, epithelioma beginning as a wart or an ulcer, and not as an infiltration. Microscopical examination of a portion of the removed growth and the effect of specific treatment should definitely and promptly settle the diagnosis.

The cicatrices of healed gummata are depressed and adherent to deeper structures.

SYPHILITIC AFFECTIONS OF THE APPENDAGES OF THE SKIN

Syphilitic Alopecia and Onychia.—Syphilitic alopecia appears with the early secondary symptoms—*i.e.*, about the third month from the development of the chancre; it may develop much later. There may be total or partial loss of the hair. Total loss is rare. Partial loss may develop in the form of a general shedding, the hair coming out readily and the resultant appearance of the scalp simulating that of advanced baldness from other causes. More characteristic is the shedding of hair in irregular, usually rounded, scaling

Fig. 412.—Ulcerating gummata of the malleolar region. (From the collection of photographs of Dr. George Henry Fox.)

patches, giving the scalp a typical moth-eaten appearance. Both the general and the circumscribed alopecia are often associated with papular and papulopustular lesions of the scalp. As has been stated, the prognosis of these forms of alopecia is usually favorable, the hairs growing again on the absorption of the infiltrate which interferes with their nutrition.

Circumscribed alopecia due to ulcerating and tubercular syphilides is permanent, since the lesions entirely destroy the hair-follicles (Fig. 413).

The diagnosis of specific alopecia is founded on the rapidity of the process, the history of syphilis and associated symptoms of the disease, and the patchy, moth-eaten appearance of the scalp, the bare spots showing prominent follicles

and a scaling surface. When the alopecia is partial, shedding of the hair is most noticed over the posterior portions of the scalp, thus differing from ordinary baldness.

In addition to vigorous constitutional treatment, shampooing, massage, and active counter-irritation are indicated.

Onychia is an expression of the influence of the syphilitic poison on the matrix of the nail and on the periungual and subungual epidermic tissue. The nails may become dry, brittle, lustreless, and break on the least pressure (friable onychia). They may be fissured and loosened from their matrices, to be

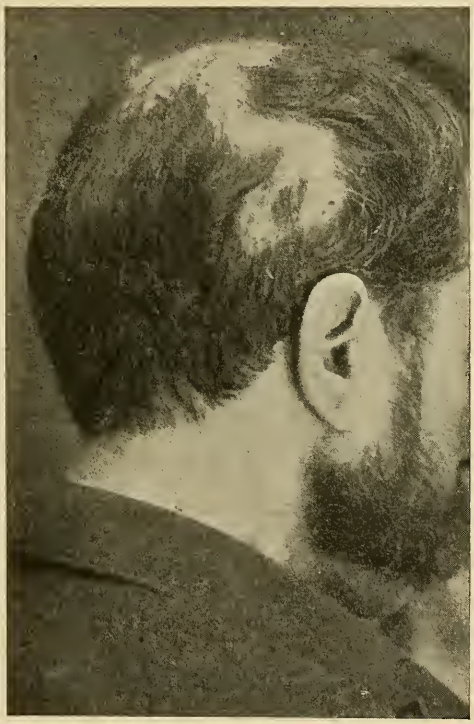


FIG. 413.—Syphilitic alopecia following ulcerative lesions. (From the collection of photographs of Dr. George Henry Fox.)

finally shed completely, giving place to a new nail. Sometimes the nail becomes greatly discolored, thickened, and distorted (onychia hypertrophica).

These forms of onychia are usually observed in the early secondary period of syphilis. They are painless, non-inflammatory, and produce no permanent deformity, the new nail-tissue being healthy in appearance when active constitutional treatment has succeeded in overcoming the specific virus. The nails of the fingers are more frequently attacked than those of the toes.

Paronychia may develop as an indolent persistent inflammation which may be dry or moist.

The *dry paronychia,* or non-ulcerative form of the affection, is commonly

associated with the papular syphilides. It begins either as a papule which involves the cutaneous folds, occasioning horny thickening and exfoliation of the epidermis, or as an infiltration surrounding the nail, much as would an ordinary "run-around," except that it is chronic in its course, painless, and exhibits a deep coppery color. In either case the nail is often brittle, cracked, and deformed.

Moist paronychia, or the ulcerating form of the affection, is often associated with the vesicular or pustular syphilides. It begins as in the dry form, but goes on to ulceration, the infiltrate becoming fissured and suppurating. As a result there is found about the periphery of the nail, and frequently undermining it, an unhealthy ulcer, the granulations of which may become exuberant. There may be swelling of the extremity of the digit as marked as that observed in felon. The digital chancre may closely simulate a moist paronychia. It is usually more acute in its course and is distinctly painful.

Diagnosis.—The diagnosis of syphilitic paronychia is founded on the painless, chronic course of the affection, the absence of acute inflammatory symptoms, and the presence of other signs of syphilis.

The nail is frequently shed, and, if the ulceration has been sufficiently deep to destroy the matrix, will not be reproduced. It usually grows again, but is shrivelled and deformed. The infiltrate may remain for many months.

Treatment.—The treatment of ulcerating paronychia is primarily that suited to the management of secondary syphilis. The local treatment must be conducted on general surgical principles. Prolonged immersion in weak, hot bichloride solution (1 to 2000), followed by the application of moist compresses wrung out of the same solution and kept from drying by the application of waxed paper or oiled silk, will aid in rendering the ulcerating surface clean and will promote healing.

When the granulations are indolent and exuberant, forming a mushroom-like growth, they may be thoroughly curetted, or their surface may be sprinkled with dry powdered lead nitrate, an ordinary gauze dressing being applied over this. When ulceration has undermined the nail, the latter should be trimmed away sufficiently to allow thorough local treatment to be applied to the entire diseased surface. Iodoform and aristol are both useful applications, but only when they are brought in direct contact with the ulcer. When cicatrization has taken place, careful strapping with thin strips of resin adhesive plaster, repeated daily, will encourage the formation of a symmetrical nail.

CHAPTER XXXVI

SYPHILITIC LESIONS OF THE MUCOUS MEMBRANES AND ALIMENTARY TRACT

The mucous membrane manifestations of syphilis correspond in pathology and general features with those appearing on the skin, the difference depending upon increased vascularity, diminished resistance to extension and ulceration on the part of the surrounding macerated mucous membrane, and a greater or less degree of irritation incident to secretions which are constantly brought in contact with the lesions.

Erythematous Syphilide.—This attacks the throat, the vagina, the urethra, the glans penis, and the inner surface of the foreskin. It may develop on any mucous surface of the respiratory, digestive, or genito-urinary tract. As in the case of the corresponding skin eruption, the lesions first appear as discrete spots; these become confluent in a few hours, exhibiting then a somewhat sharply circumscribed circinate margin.

The mucous membrane of the throat is most frequently attacked, the patient suffering from syphilitic angina, which may assume the acute or the chronic form. The hyperæmia and œdema involve the pharynx, tonsils, half-arches, and soft palate, but rarely extend to the hard palate, though the latter may exhibit discrete macules.

So quickly does the macular eruption of the mucous membrane become confluent that, when first observed, the lesions depending upon their location closely simulate simple sore throat, balanoposthitis, vaginitis, or urethritis. It is most important to recognize the syphilitic nature of such lesions, since they may appear before other more characteristic secondary symptoms, or as the only manifestation of the disease, and since their discharges are contagious.

Diagnosis.—The diagnosis will usually be founded on associated signs or symptoms of syphilis, and on the absence of a cause for simple inflammation. There is nothing typical or characteristic in the local appearance.

Papular Syphilide.—The papular eruption upon the mucous membranes may appear as a denudation or erosion, as a circumscribed diphtheroid patch, as a vegetating papule, as a superficial ulceration, or as a scaly patch. These lesions are more prone to recur than the homologous lesions of the skin, and are more obstinate to treatment.

They are exactly simulated by the papular syphilide, as it develops about the mucous orifices, on the scrotum, beneath the breasts, or in any region where heat, moisture, and friction modify the eruption.

All forms of papular eruption are classed under the general heading of mucous patches, though this term is often limited to lesions covered by a gray-white pseudo-membrane or to the later scaly eruption of the mucous membrane.

The papular erosion appears in the form of oval or rounded, small or large, infiltrated patches, exhibiting a raw-ham color, denuded of epithelial

covering, and showing a smooth, glistening surface. It is usually placed on the dorsum of the tongue, and associated with it are found fissures of the borders of the organ, and mucous patches. It is particularly common in inveterate smokers and hard drinkers; and, indeed, this is true of all the mouth lesions of syphilis.

The **diphtheroid papule**, the commonest form of the mucous patch, appears as a small or large, discrete or confluent papule covered with a tightly adherent, gray-white pseudo-membrane, which on being removed leaves a bleeding surface. The diphtheroid membrane is but little elevated above the level of the surrounding healthy surface. It is somewhat sharply defined from the latter by a narrow hyperæmic zone often exhibiting the dusky-red coloration of syphilitic lesions. There may be central absorption of the infiltrate and healing in this portion of the lesion while there is extension at the periphery, thus producing ring-like and serpiginous figures.

This form of mucous patch is generally found on the mucous membrane of the cheeks and lips and at the angles of the mouth, where it becomes fissured, on the sides, under surface, and frænum of the tongue, on the gums, and on the soft palate, half-arches, and tonsils.

The lesions may be attended with fissuring, with superficial ulceration, and, when situated on the tonsils, with deep and destructive ulceration. Under these circumstances they may become extremely sensitive, interfering with eating and drinking, even with speaking, and occasioning an annoying flow of saliva.

When the mucous patch is undergoing involution, either under the influence of constitutional or local treatment or spontaneously, and loses its diphtheroid covering, it presents the appearance of a papular erosion, then heals over, exhibiting a temporary pigmentation.

When these diphtheroid papules become distinctly inflammatory in type they may react upon the anatomically related lymphatic nodes, producing enlargement, and in some cases, from mixed infection, suppuration.

The **vegetating papule** exhibits the tendency towards local hypertrophy which is sometimes a marked feature of syphilitic lesions.

The infiltration common to all the lesions of syphilis is in the case of this manifestation of the disease particularly well marked; in addition, the papillæ of the mucous membrane are greatly hypertrophied; there results a raised lesion, which is in reality an infiltrated papilloma, varying in size from that of a split pea to that of a half-walnut.

The surface of this lesion may be covered with a gray-white false membrane, or may present an eroded appearance. The lesions have a marked tendency towards peripheral extension, and when several are placed near together these are likely to become confluent.

The vegetating papule is comparatively rare upon mucous membranes. It is commonly encountered about the vulva in women and in the anal region in men. From infiltration the surface upon which these lesions are placed loses its elasticity, so that rhagades or fissures are likely to occur.

Superficial ulcerations are frequently associated with the vegetating papules; these represent infiltration in which there has been destruction of tissue, a dis-

tinct, punched-out, freely secreting ulcer occupying the site of a lesion which in its early stages presented the appearance of a vegetating papule. This ulcerating lesion is more frequently encountered upon the skin than upon the mucous membranes.

Papulo-Squamous Syphilide.—The *scaly patches* (mucous psoriasis, opaline plaques) rarely appear in the course of constitutional syphilis. They are rounded or irregularly shaped, flat, smooth, bluish-white patches, such as would result from lightly brushing a surface with strong silver nitrate solution. The white coloration is due to changes in the epithelium, consequent on chronic irritation and inflammatory infiltration. The normal columnar cells are replaced by squamous epithelium arranged in many layers, producing a species of cornification identical with that described when considering the pathological changes incident to chronic urethritis; as the thickening is greatest at the centre and becomes less marked towards the periphery, so the color shades into that of the surrounding mucous membrane. The thickened epithelium is itself adherent to the underlying surface, but its removal does not occasion bleeding. Frequently the central thickened epithelium exfoliates, while the lesion extends peripherally, leaving either a surface of hypertrophied and infiltrated papillæ, a distinct erosion, or even healthy mucous membrane surrounded by a white ring of epithelium. From confluence of such patches curious markings are sometimes observed on the tongue.

This lesion is most frequently observed on the buccal mucous membrane, along the alignment of the upper and the lower teeth when the jaw is closed, the patches usually being more or less confluent. It also develops on the inner surface of the lips, and on the dorsum, sides, and under surface of the tongue.

As with other lesions of syphilis, there is little pain excited by white scaly patches, except where they are associated with fissures and ulcerations.

Unlike the other forms of papular eruption, the scaly patch usually denotes a late stage of the disease. It may develop at any time in the late secondary and tertiary periods, and is usually exceedingly obstinate to treatment.

Gummata may develop in tertiary syphilis, both in the mucous membrane and in the submucous connective tissue. They may take the form of diffuse infiltrations or of circumscribed tumors.

The mucous gummata appear as small tumors, which rarely reach the size of a pea before breaking down, forming punched-out, unhealthy ulcers, about the circumference of which is often to be noted a raw-ham-colored infiltrate.

These lesions peculiarly affect the hard and the soft palate, and often exhibit a serpiginous grouping and a slow extension in one direction while cicatrization is taking place in the ulcer which first developed.

The submucous gummata form larger tumors before breaking down. They exhibit, however, a marked tendency to soften towards the surface, producing deep, punched-out ulcers with infiltrated borders.

The ulcerating gummata are responsible for the stenosing cicatrices which may develop in nearly any portion of the alimentary canal, though they are most frequently recognized in the œsophagus and the rectum.

Diagnosis of Mucous Syphilides.—To distinguish the erosive and diphtheroid forms of the mucous patch from the ulcers of simple aphthæ is, from the appearance of the lesions alone, impossible. Aphthæ, however, are generally more tender, more liable to be discrete, develop in a day or two, run a rapid course, and, either with or without treatment, are well in a few days.

The difficulty in diagnosis is made much greater by the fact that it is especially in syphilitics that aphthous spots are liable to develop. Fournier describes a recurrent herpes which attacks the oral mucous membrane of syphilitics, producing small erosions which exactly resemble mucous patches. This eruption develops some years after a methodical course of treatment has apparently eradicated the syphilitic taint. Specific treatment is absolutely without effect, the erosions disappearing spontaneously in a few days and recurring at irregular intervals.

In making a differential diagnosis between the erosive and diphtheroid forms of mucous patches, aphthæ, and herpetic lesions, the history of the case, the presence of other signs of syphilis, and the effect of constitutional treatment would all lead to a correct decision.

The *scaly patches* (mucous psoriasis, opaline plaques) can not always be distinguished from non-specific *leucoplakia* (hyperkeratosis). The latter sometimes develops acutely, particularly in women and children. From the syphilitic lesions spirochætes may be recovered.

The idiopathic leucoplakia—*i.e.*, that of non-syphilitic drinkers and smokers—is even slower in development than the specific lesion; the white color and the heaping up of epithelial cells are more marked and irregular; there is not the same tendency towards central exfoliation, as the lesion extends peripherally,—hence the resultant ring-like configuration is less common. In leucoplakia the lesions are more often found on the tongue and the lower lip, subjective sensations are said to be more marked, and specific treatment is absolutely without avail in effecting a cure.

The points of difference by which ulcerating gummatous lesions of the mucous membrane can be distinguished from the tuberculous and malignant infiltrations will be considered when discussing the subject of gummata in special regions.

Treatment.—The treatment of mucous syphilides is constitutional and local, topical applications being much more distinctly indicated than is the case with skin lesions, except when the latter assume the form of mucous patches.

Syphilis of the Tongue.—Chancre is rare upon the tongue, but when present is usually at or near the tip of this organ (Du Castel). It is of the erosive type, and presents no peculiarities of development.

Roseola is rare and ephemeral. It appears in the form of slight desquamative stains.

Mucous patches are of the erosive, diphtheroid, and vegetating types; the last variety is rare. When mucous patches are numerous and confluent there is general swelling of the tongue, the latter showing on its borders the imprint of the teeth. Mucous patches placed along the sides of the tongue—

a favorite seat—often exhibit more or less fissuring, in which case they may be accompanied by much pain.

The ulcerations of secondary syphilis are usually small and superficial, and are attended with few subjective symptoms; even should they become deep, inflammatory symptoms are not marked.

Smooth patches (Fournier) are not very perceptible till the tongue is dried by a towel or some absorbing fabric. They then appear as smooth, shining surfaces from which the epithelium has entirely disappeared. There is no sign of erosion. The lesions are circular in form, and are grouped in circles or segments of circles.

This form of desquamating glossitis is found in both the secondary and the tertiary period of syphilis. It at times precedes the formation of syphilitic leucoplakia.

Scaly patches (syphilitic leucoplakia) are rarely seen except on the tongues of habitual smokers and drinkers. They exhibit the gray-white, circular, circinate, or annular stains already described, and occasion no symptoms unless extensive, when they may be associated with some stiffness of the tongue, interfering with articulation; there may also be tingling and a feeling of numbness. The importance of these lesions lies in the fact that they are prone to become fissured and cancerous.

The strictly tertiary lesions of the tongue may appear either in the form of a diffuse gummatous infiltration (sclerous glossitis) or as circumscribed gummata. These gummatous lesions develop on the tongue more frequently than in any other portion of the mouth. They are much more commonly observed in men than in women, probably because of the chronic irritation produced by the use of tobacco and alcohol.

Diffuse gummatous infiltration, or syphilitic sclerous glossitis, is really a form of chronic myositis. It may be either superficial or deep, and may involve part of the tongue or the whole organ.

The affection begins as a slowly progressive, hard swelling, usually involving but one side of the tongue, and producing marked asymmetry. When both sides are enlarged there may be so much swelling that the patient will not be able to close his mouth. This condition develops with comparatively slight symptoms. There is no pain, the patient complaining only of a feeling of weight and stiffness, making articulation somewhat labored. After weeks, or perhaps months, the swelling gradually subsides coincidently with the occurrence of atrophic changes, which produce even greater stiffening and induration than were present in the early stages of the affection.

Examination of the surface of the tongue then shows irregular lobulations, with marked alteration of the mucous membrane. There are often smooth, red patches, due to exfoliation of epithelium, or areas of greatly thickened epithelium, which may present the typical white appearance of syphilitic leucoplakia.

From mechanical irritation by the teeth, cracks, erosions, and ulcers are often formed.

Circumscribed gumma, or gummatous glossitis, may be superficial or deep—that is, it may involve the mucous or the submucous tissues, or may start in the substance of the muscles.

The *superficial gummata* appear as small, round, hard nodules of the mucous membrane or submucous connective tissue. They vary in size from that of a grape-seed to that of a cherry. They occasion little or no pain, and if not treated by internal medication usually soften and ulcerate, forming punched-out, indurated, undermined, unhealthy ulcers.

When these gummatous ulcers are multiple and confluent, and particularly when they are phagedænic in type, they may destroy the greater part of the tongue, and may threaten life from backward extension of the inflammation and sudden œdema of the glottis.

The deep or muscular gummata begin as hard, painless tumors, firmly adherent to the surrounding tissues. They are nearly always placed on the dorsum of the tongue. They occasion little or no pain, causing inconvenience only from the limitation of motion. They grow slowly, usually not softening and ulcerating for two or three months. They vary in size from that of a cherry to that of a lemon. When they finally ulcerate, deep, punched-out, indolent, indurated ulcers are found.

The ulcerating gummata of the tongue, even though deep and confluent, excite little pain except on motion, and, indeed, all the symptoms of acute inflammation are absent. On the healing of the ulceration there results a scar, which may be both disabling and deforming.

Diagnosis.—The diagnosis of syphilitic affections of the tongue is made upon the general principles discussed when treating of syphilis of the mucous membranes.

It is particularly on the tongue that the lesions of recurrent herpes are manifested, and it is here that they are most frequently taken for mucous patches or other lesions of active syphilis.

Among other affections simulating syphilis of the tongue, such as ichthyosis and superficial glossitis, is a disease of infancy variously characterized as erratic rash, circinated herpes, or geographical annulus migrans. The tongue becomes covered with concentric rings formed by small red patches. The senses of taste and touch are normal; sometimes, however, they may be slightly hyperacute. This disease may easily be mistaken for mucous patches or for congenital syphilis.

Ulcerating gummata of the tongue may readily be confounded with tuberculous or cancerous lesions.

Tuberculous lesions are usually single, and are seated at or near the tip or on the dorsal surface of the organ. They begin as cracks or fissures, attended by swelling, and slowly form shallow, jagged, painful ulcerations, with non-indurated borders, which are often surrounded by minute, pale-yellow points with opaque centres. These are tuberculous granulations undergoing caseous degeneration. They are frequently thrown off by ulceration, and are never seen in syphilis. Tuberculous glossitis rarely appears as an isolated symptom of the diathesis, the larynx, lungs, or other organs generally showing involvement. The tubercle bacillus may be found on microscopic examination, or may be cultivated by inoculation of guinea-pigs. The lesion is slow in its course, and is not favorably influenced by specific treatment.

The gumma begins as a single submucous or muscular mass, opening after

a time by a narrow passage, ulcerating and discharging like a furuncle, having a sloughing indurated base.

Carcinoma is generally found at the borders of the tongue, as a consequence of long-standing irritation. It begins as an erosion or ulcer, which subsequently becomes indurated, may show about its borders epithelial pegs, is shortly followed by lymphatic involvement, is steadily progressive and somewhat rapid in its course, and is frequently very painful. The diagnosis may be obscured, indeed rendered impossible, by the fact that carcinoma and gumma may develop side by side.

The points of difference between carcinoma and ulcerating gumma are embodied in the following table (Fournier):

Epithelioma.	*Gumma.*
Period of Occurrence.—Chiefly after the fiftieth year.	*Period of Occurrence.*—Earlier in life.
History.—Often cancerous, and preceded by lingual psoriasis.	*History.*—Not cancerous. Not preceded by lingual psoriasis.
Location.—Often on the lateral and under surface of the tongue; unilateral.	*Location.*—Always on the dorsal surface; may be bilateral.
Number.—Single.	*Number.*—May be multiple.
Beginning.—An irregular, indurated, superficial ulceration, which extends rapidly. Marked induration follows ulceration.	*Beginning.*—A thick, rounded induration, opening like a furuncle, and leaving a deep hollow ulcer. Marked induration precedes ulceration.
Appearance.—Elevated, irregular, everted borders; ulcerating surfaces bleeding rapidly on mechanical interference. No cavity resembling abscess.	*Appearance.*—Punched-out, sharply defined edges; sloughing surface, not easily excited to bleeding. Excavation like an abscess-cavity.
Discharge. — Profuse, offensive, irritating.	*Discharge.*—Moderate, not very offensive.
Symptoms.—Lancinating pain often darting towards the ear; great functional disturbance (deglutition, mastication, speech, etc.). General cachexia.	*Symptoms.*—Nearly painless; only slight functional disturbance. No cachexia.
Lymphatic Involvement. — Submaxillary lymphatic nodes progressively enlarged and densely indurated.	*Lymphatic Involvement.*—None, or slight swelling and tenderness.
Therapeutic Test.—Specific treatment use less or harmful.	*Therapeutic Test.* — Specific treatment curative.
Microscopic Examination.—Pearly bodies.	*Microscopic Examination.* — Embryonal cells in various stages of granular degeneration.

Syphilis of the Gums.—Aside from the pyorrhœa induced by medication, and arising from deranged digestion and secondary lesions in the mouth, occasionally there is noted in tertiary syphilis a distinct pyorrhœa alveolaris, signifying syphilitic disease of the bone. This, unlike the pyorrhœa of medication, is cured by rapidly pushing the treatment.

Syphilis of the Palate.—The soft palate, uvula, and half-arches usually show the diffuse or macular erythema of the early secondary specific anginas; mucous patches are also frequently found attacking these structures.

Gummata of the hard palate usually begin in the periosteum, and are found in or near the middle line, forming elevated, sometimes painful, usually

multiple, elastic swellings, which shortly soften and ulcerate, exposing the bone, resulting in necrosis of the latter and in direct communication between the cavities of the nose and the mouth.

When these gummata begin on the oral surface of the palate they usually can be detected in time to prevent perforation.

When, as is more commonly the case, they develop on the nasal side of the palate, there is often no suspicion of trouble till a dusky, œdematous, circumscribed swelling appears on the roof of the mouth, which in a very few days shows an opening into the cavity of the nose. This opening represents the small end of a funnel-shaped ulcer, which on examination from the nasal side of the palate may be found to be of considerable size.

The gummata may be multiple, and by confluence may produce large openings in both the hard and the soft palate. They sometimes develop very rapidly, destroying the uvula and the greater part of the soft palate in a few days. When these ulcerating gummata heal there may result great cicatricial deformity, and perforations which can be closed only by plastic operation.

Gummata of the soft palate develop slowly, without pain or discomfort on the part of the patient. There may be a general nodular infiltration, or but a single gumma at one point. Ordinarily there is a diffuse infiltrate, which can be distinctly felt on palpation. If this primarily involves the pharyngeal wall of the palate, the only appreciable symptoms will be stiffness and immobility, which are diagnostic signs of considerable value. These signs can be elicited by exposing the pharynx while the throat is being examined and instructing the patient to utter some sounds requiring the assistance of the soft palate for their production. When immobility is thus detected and is found to be associated with nodular induration, the diagnosis of gumma can be made at once. If the anterior wall is involved, the dark red, œdematous, sometimes nodular mucous membrane will suggest the nature of the affection. This diffuse infiltration is prone to ulcerate, destroying a part or the whole of the palate and uvula. The inflammatory process is not limited to the soft palate, often extending to the anterior and posterior half-arches. The cicatricial processes following ulceration may produce great deformity. The soft palate may be partly or totally wanting, or may be adherent to the posterior pharyngeal wall, partly or completely separating the naso-pharynx from the pharynx; though not adherent, it may be stretched tightly across the naso-pharynx, having entirely lost its suppleness and mobility.

Circumscribed gummata of the soft palate may be single or multiple; they are commonly placed on the oral surface. They usually ulcerate if untreated, often causing perforation. Mauriac has called attention to the fact that gummatous ulceration involving the velum, the tonsil, the half-arches, and the lateral wall of the pharynx, and opening up the Eustachian tube, often begins in the recess formed by the juncture of the anterior and posterior half-arches and the upper surface of the tonsil. This ulceration may be extensive and rapid, spreading wide of the tonsil and palato-pharyngeal fold and even eroding the carotid artery.

Syphilis of the Pharynx.—Gummata of the pharynx may be submu-

cous or subperiosteal. They usually appear as one or more hard, painless swellings of the posterior wall. Softening and ulceration follow, resulting in deep, punched-out, indurated ulcers. When gummatous ulceration involves both the soft palate and the pharynx, adhesions may take place in the process of healing, which shut off the nasal cavity from the mouth; or by involvement of the half-arches and tonsils the pharyngeal communications between the mouth and the larynx may be greatly narrowed.

The late ulcerating lesions of the soft palate and the pharynx are often accompanied during their evolution by pain, disability, and interference with hearing, and may be followed by intractable catarrh of the naso-pharynx incident to the deformity following cicatrization.

As a result of this cicatricial contraction the voice may be markedly altered; deglutition may be difficult; or the isthmus of the fauces may be so narrowed that there will be marked obstruction to the entrance of air. Such cicatrices are almost pathognomonic of syphilitic ulceration.

Gummata of the pharynx are generally associated with tertiary infiltrations of the nasal or the oral mucous membrane. The throat often presents an irregularly ulcerated appearance, and exceptionally extremely chronic, distinct, punched-out, typical gummatous ulcers develop, which, if untreated, may extend to the underlying bone.

The Tonsils.—Gummata are very rarely observed upon the lips or cheeks, and are comparatively rare upon the tonsils.

The ulcerating lesion commonly observed on the tonsil and often considered gummatous is in reality a vegetating papule, which ulcerates, spreads somewhat rapidly, and may assume a diptheroid or even a phagedænic type. The ulceration is much more superficial than is that of gumma.

Gummatous tonsilitis is characterized by painless, hard enlargement, with little functional disturbance, except perhaps some interference with hearing. The mucous membrane, at first stretched tightly over the swelling, becomes somewhat less tense as softening takes place, and finally ruptures. Then result one or more punched-out ulcers with indurated borders and gray sloughing surfaces. These may become confluent, involving the anterior half-arches, and may produce marked deformity when healing takes place. Cicatricial contractions resulting from these gummata may cause permanent closure of the Eustachian tube and interference with hearing.

Subperiosteal gummata, resulting in caries and necrosis, are most frequently observed on the hard palate, the alveolar border of the upper jaw at the insertion of the incisor teeth, and the posterior wall of the pharynx.

The Œsophagus, Stomach, and Intestines.—It is apparent from a few reported cases and from many autopsies that gummatous ulceration may occur in any portion of the alimentary canal. It seems probable, also, that the mucous membrane of this tract is subject to specific general or local inflammation during the secondary period of the disease. Thus the symptoms of catarrhal gastritis or gastro-enteritis which are so frequently associated with syphilitic fever or are observed before or during the outbreak of the first erythema may be due to the direct effect of syphilis upon the stomach and bowels. The chronic gastritis often associated with specific lesions of the liver

or spleen may also represent a specific infiltration, since it is favorably influenced by specific treatment.

The Œsophagus.—The superficial lesions of early syphilis have not been recognized in the œsophagus. Deep ulceration extending from the pharynx is followed by stricture. Infiltrating gummata developing in the submucous connective tissue commonly ulcerate, eventually forming incurable strictures. The diagnosis during either the ulcerating or the cicatrizing stage of the lesion is dependent absolutely on the finding of associated signs of syphilis, in the absence of other etiological factors, and on the effect of vigorous constitutional treatment. This, if pushed in the ulcerating or early contracting stage, should produce rapid improvement in the symptoms of œsophageal narrowing.

The Stomach.—In addition to the symptoms of acute and chronic catarrh, those of gastric ulcer are sometimes noted. This, even though occurring in a syphilitic, may be non-specific in nature, or it may be due to the breaking down of a gumma. The symptoms of gastric ulcer of syphilitic origin do not differ from those of the non-specific ulcer. The diagnosis must be founded on a therapeutic test.

The Intestines.—Except the beneficial results of specific treatment, there is no feature of acute or chronic syphilitic enteritis to distinguish it from non-specific catarrh.

Ulceration of the small intestine may be due to the breaking down either of a gumma or of the lymph-nodes of the intestinal wall. According to Rieder's researches, ulceration of the bowel is most frequent in the upper portion of the small intestine. The ulcers are multiple and grouped, exhibit the characteristic infiltration of gummatous ulcers, and are late tertiary manifestations. They involve all the coats of the bowel. They may result in cicatricial stenosis.

These lesions offer no clinical features peculiar to themselves. Their nature can be suspected only from associated symptoms of syphilis.

Syphilis of the Liver.—The liver may be affected in both the secondary and the tertiary periods of syphilis. Involvement in the secondary period is rare; tertiary lesions, however, affect the liver more frequently than they do any other abdominal organ.

Precocious syphilis of the liver appears in the first three months of the constitutional disease as hypertrophy, which may or may not be accompanied by pain, tenderness, and jaundice. The hypertrophy is general, and may enlarge the liver to twice its normal size. On palpation no nodules are found, simply a general increase in size. The prognosis is good, the enlargement gradually diminishing under constitutional treatment till in from one to three months the liver is again normal in size.

Jaundice developing during the late secondary period is rarely due to syphilis. The great majority of such cases, when unattended by hepatic enlargement, are caused by intercurrent affections, such as a catarrhal condition of the bile-ducts, and are neither directly nor indirectly dependent upon constitutional syphilis. Calvert has, however, collected one hundred and twenty-seven cases of jaundice occurring as a manifestation of secondary syphilis, and notes that it is rapid in appearance, varies greatly in intensity, recurs,

and is not associated with grave digestive disturbances. Icterus gravis is most exceptional. The diagnosis is based on the history and associated symptoms of syphilis and upon the rapid improvement under specific treatment.

Tertiary syphilis of the liver may appear as interstitial or as gummatous hepatitis. These tertiary lesions are in marked contrast to the secondary involvement of the liver from the fact that they rarely appear till late in the disease, from the fourth to the fortieth year. They are frequent, they are persistent and rebellious in treatment, and they produce permanent alteration in the liver-substance.

The abuse of alcohol, traumatism, and carelessness in treatment seem to be the factors which particularly predispose the liver to tertiary manifestations of syphilis.

Interstitial Hepatitis (diffuse gummatous infiltration).—This runs very much the course of an ordinary cirrhosis. It begins as a hyperæmia, accompanied by an abundant small round-celled infiltration of the perivascular connective tissue of the liver. This cellular hyperplasia generally appears in disseminated patches of perihepatitis, resulting in adhesions to surrounding organs. The infiltration of the substance of the liver may be general, though it is commonly found in patches. The cellular infiltrate becomes, in part at least, converted into connective tissue, which by its contraction causes narrowing and obliteration of ducts and vessels and atrophy of liver-cells. There is at first an increase in the size of the liver, general or localized, depending upon whether hyperæmia and cellular infiltrates are diffuse or appear in discrete patches. Ultimately, as the round-celled infiltrate in part undergoes fatty degeneration and is absorbed, in part becomes converted into connective tissue and contracts, the enlarged liver becomes smaller; but this lessening in size does not stop when the organ has reached its normal dimensions; the atrophic process steadily advances; the surface of the organ is lobulated, is marked by deep furrows, is creased by dense fibrous bands, and the liver is distorted almost beyond recognition. The contraction of the fibrous bands is often so pronounced that some of the lobulations thus produced are almost completely cut off from the rest of the liver, seeming to be attached only by the fibrous tissue surrounding the base.

Together with atrophy in one portion of the liver there may be overgrowth in another. This may be due to compensatory hypertrophy, the intact portion of the liver-substance developing so that it may take the place of the portion destroyed.

The furrowing and lobulation are usually much more distinctly marked upon the convex than upon the concave surface of the organ.

Gummatous hepatitis is characterized by the formation of gummata identical in structure with similar tumors observed in other portions of the body. These tumors vary from the size of a pea to that of a hen's egg; they are most frequently found in the region of the suspensory ligament and along the course of the portal vein, though they may appear in any part of the liver; they may be grouped or irregularly disseminated. They are gray or yellowish in color, and either solid throughout or broken down in the centre, according to the period of evolution.

As the gummata soften centrally, undergoing fatty and caseous degeneration and becoming absorbed, the peripheral portion of the neoplasm is converted into fibrous tissue, which, contracting, produces on the surface of the liver deep irregular puckerings, sometimes so marked as seemingly to divide the right lobe of the liver into two halves. In the deeper portion of the liver irregular branching nodules are formed, in the centre of which is sometimes found a small amount of caseous material.

There is nearly always associated with these gummata perihepatitis, resulting in adhesions between the liver and surrounding structures; this is particularly marked on the upper surface, and may so limit the respiratory movements of the organ as to constitute a sign of some diagnostic value. Interstitial hepatitis and amyloid degeneration of the liver, spleen, kidneys, and intestinal mucous membrane are also frequently noted in connection with old gummata.

The gummata of the liver do not ulcerate; they develop slowly, and may not reach their ultimate stage of cicatrization for several years.

Symptoms.—The symptoms of syphilitic interstitial hepatitis are rarely well marked. In the early stage there is a feeling of weight in the hepatic region, followed, often after a long period, by hypertrophy, slow in development, and unattended by signs of inflammation. Sometimes the hypertrophy is general, the lower border of the liver extending three finger-breadths below the margin of the ribs, and revealing to palpation a smooth, regular surface. Often the hypertrophy is not so marked, palpation showing surface irregularities or elevations. It is dependent upon compression of the portal vein from perivascular hyperplasia.

Functional disturbances are limited to general dyspeptic symptoms, even these not being noted at times. As the disease progresses and atrophy sets in, the only sign which may be considered characteristic is the deformity incident to cicatricial contraction. A nodular surface, an irregular fissured border, gradually becoming less perceptible to palpation in one portion while overgrowth is observed in another region, and adhesions to surrounding structures, are all signs which would suggest syphilis.

Icterus is comparatively rare; hæmatemesis, diarrhœa, digestive troubles, and swelling of the legs develop as in the case of cirrhosis from causes other than syphilis.

Ascites is frequently noted; fluid accumulates slowly in the first place, but on tapping reaccumulates rapidly. Often there are no premonitory symptoms; a painless ascites gradually develops, associated with jaundice, discolored urine, swelling of the ankles, varicose veins, and possibly albuminuria.

Gummatous hepatitis in the early stages may give rise to no symptoms, and may not seriously interfere with the functions of the liver. As the disease progresses, the accompanying hepatitis, perihepatitis, and amyloid degeneration cause most of the suffering and interference with general health. The liver is usually of normal size, presenting to the examining finger a nodular irregular border. Gastro-intestinal symptoms are marked, pain may be severe and constant, and, when the atrophic process is well developed, bleeding from the stomach or from the œsophagus may become a serious complication.

Enlargement of the spleen and albuminuria are commonly associated with

specific hepatitis. As a consequence of this involvement of the liver, spleen, and kidneys, pronounced cachexia ensues.

Prognosis.—The prognosis of tertiary syphilis of the liver is, if the affection is taken in its earlier stages, fairly good. The gummatous form yields more readily to specific treatment than the diffuse or cirrhotic form. When extensive fibroid changes have taken place, and particularly when there are associated lesions of the kidneys and spleen and marked cachexia, the prognosis must be exceedingly guarded.

Diagnosis.—The diagnosis of liver syphilis is founded upon alterations in the size and shape of the liver, associated with much milder symptoms than are attendant on such alterations when they are due to other causes. There is usually a history of syphilis; or a positive Wassermann, or both.

Gummatous hepatitis may simulate cancer. The latter affection, however, occurs in those past middle age, and is rarely primary. It is not so liable to contract adhesions as are gummata: hence its nodulations are more readily felt; it produces early and profound cachexia; it grows much more rapidly than gumma, and associated enlargement of the spleen is rare.

Treatment.—All forms of hepatic syphilis occurring in the early secondary period should be treated by arsenic and mercury.

In the form generally observed—that is, as a late tertiary manifestation—in addition to the specific drugs potassium iodide should be administered in doses as large as the patient can tolerate. The dose required is sometimes as high as two or three drachms daily.

Tonics, mild stimulation, bathing, exercise, diet, and general hygiene must receive careful consideration.

Amyloid degeneration is so frequently associated with syphilis that the latter must be recognized as an etiological factor in its production. As when it complicates tuberculosis, it may follow extensive suppurative processes. It is also found, however, in conjunction with the sclerotic or the gummatous form of hepatitis, and is commonly complicated by a similar affection of the spleen, the kidneys, and often the intestinal mucous membrane. The liver rarely reaches the enormous size sometimes observed in amyloid degeneration from other causes.

In itself amyloid degeneration does not cause ascites, and gives rise to no functional disturbances until it is far advanced. Ultimately digestive disturbances become pronounced, and, as the result of similar degeneration of the intestinal mucosa, multiple ulcers develop, causing blood-stained stools. There is usually œdema, and, if the kidneys are also involved, albuminuria. Cachexia is well marked.

The diagnosis is based on finding an enlarged, smooth, firm, non-sensitive liver, together with other signs of late syphilis. In amyloid degeneration with gummatous or sclerotic processes the liver may be ridged, notched, or otherwise deformed.

The prognosis is extremely grave. The treatment is that appropriate to late syphilis, combined with tonics, stimulants, carefully regulated diet, and minute attention to general hygiene.

Syphilis of the Pancreas.—Specific disease of this organ may take the form of interstitial pancreatitis or of gummatous involvement.

These lesions are rare. Their presence is not indicated by characteristic symptoms during life. There is usually marked involvement of other abdominal organs.

The Rectum and Anus.—About the anal aperture, especially in women, mucous patches frequently form. These, from maceration and from the irritation incident to defecation, are prone to ulcerate, forming rhagades and fissures, which, by extending in depth, may involve the tissues of the ischiorectal space, forming deep ulcers or resulting in fistulæ. It is important to bear in mind that such lesions may occur in the secondary stage of syphilis.

Gummata may develop on or beneath the mucous membrane of the anus and rectum, or in the surrounding tissue of the ischiorectal fossa. Not infrequently they assume the form of a diffuse infiltration, producing rigidity of the walls of the bowel, the mucous membrane remaining quite healthy. This may be followed, if untreated, by ulceration or interstitial absorption, in either case resulting in stricture.

Gummatous ulceration of the mucous membrane usually begins about the internal sphincter, appearing first as one or many small nodules, which soften and break down, exhibiting dark gelatinous cores. They finally destroy the overlying mucous membrane, forming ulcers, which become confluent, extend in area and depth, and are generally accompanied by inflammatory infiltration of the muscular coat of the gut, including the sphincter, thus producing a narrowing and rigidity distinctly perceptible to the examining finger.

The ulceration frequently extends upward, other gummata forming and ulcerating. From the surface and border of these ulcers there may be an exuberant growth of granulations, producing fungous masses, which may simulate those of malignant disease.

Healing is accompanied by the formation of scar-tissue, which in its subsequent contraction often produces tight strictures.

The perirectal gummata form tumors which may reach considerable size before involving and breaking through the mucous membrane. As a result of the entrance of the bowel contents into the cavities of these gummata, ischiorectal abscesses are formed, terminating in fistulæ. These fistulæ may be vesical or vaginal, are often multiple, and in some cases riddle the entire perineum, even opening on the surface of the thighs.

The strictures resulting from cicatrization of recto-anal ulceration are much more frequent in women than in men. They are generally found involving the lowest portion of the rectum, and are often associated with vegetating ulcers.

Symptoms.—The acute or chronic proctitis often accompanying ulceration and gummata of the rectum occasions a muco-purulent discharge, a feeling of fulness in the rectum, and usually moderate tenesmus. When the ulcers become fissured and deep, burning pain, tenesmus, and blood-stained purulent discharge are prominent symptoms. The passage of fæces occasions some suffering, and is usually followed by bleeding. When stricture-formation is fairly well advanced there will be constipation alternating with diarrhœa and the passage of ribbon-shaped or broken stools.

The prognosis must be guarded. Even if active specific treatment cures the palpable lesions, there sometimes follows fæcal incontinence, from atrophy

of the sphincter consequent on interstitial myositis. Ulcers about the rectum are always extremely slow to heal.

Diagnosis.—The lesions of syphilis must be distinguished from those of tuberculosis and cancer.

The tuberculous ulcer is found in persons exhibiting other undoubted lesions of tuberculosis.

Cancer closely simulates infiltrating and ulcerating gummata. It is more prone early to contract tight adhesions to neighboring parts, and is usually placed higher up the bowel than gumma. Excision and examination of a portion of the growth would establish its pathology.

Treatment.—In addition to general specific medication, the ulcerating surfaces must be treated. When these are slight and superficial, regulation of the bowels and cleansing injections repeated night and morning may be sufficient. Deep ulcers may require stretching of the sphincter followed by prolonged rest in bed, with daily topical applications suited to the condition of the granulating surface. Strictures can be benefited only by dilatation or operation.

CHAPTER XXXVII

SYPHILIS OF THE NERVOUS SYSTEM

CEREBRAL SYPHILIS

There is no nervous symptom caused by syphilis which may not be paralleled by a symptom found in a neuropathy from another cause; in other words, there are no symptoms pathognomonic of the disease. Caries of the bones of the skull, indirectly implicating the brain, produces the same symptoms whether the caries be tuberculous, traumatic, or syphilitic, and pachymeningitis, endarteritis, and cerebral growths cause similar symptoms regardless of their etiology, but dependent rather on their rate of progress.

Etiology.—A nervous temperament seems to predispose to the development of brain-lesions, though from this it must not be understood that brain-workers are more prone to suffer from this form of the disease than are others. The conditions which certainly predispose to the development of brain-symptoms during the course of syphilis are absence of a sufficiently long and thorough course of specific treatment during the secondary and the early tertiary period of the disease, alcoholism, or hereditary neurosis. The rheumatic diathesis, traumatism, prolonged worry or anxiety, and exposure to cold or heat are also held to favor the same result.

In the large majority of cases in which syphilis attacks the nervous system, it does so in the absence of any obviously sufficient cause, and " simply," as Mauriac says, "because, forsooth, it pleases it to do so."

Mauriac and Broadbent, among others, have observed that in cases of cerebral syphilis the primary lesion and the early manifestations are more than likely to have been quite insignificant; no positive conclusion, however, can be based upon this observation, because no one would maintain the truth of its converse—viz., that because the secondary lesions or manifestations were severe, no invasion of the nervous system would follow. The probable reason why syphilis attacks the nervous system after a light secondary stage is that, on account of its mildness, a sufficiently vigorous and prolonged treatment was not enforced. Violent nervous disturbances occurring at the time of the secondary eruption and disappearing with it do not necessarily indicate a future determination of the disease to the brain or the spinal cord; but if these disturbances increase after the disappearance of the cutaneous eruption, or if after disappearing they reappear, the prognosis as regards cerebropathies must be guarded.

Time of Appearance.—Neural syphilomata are the most precocious of all the tertiary manifestations; the nervous centres may be attacked at any period of the disease after the beginning of the secondary stage. The usual time for their appearance is in the first three years after infection, but they may manifest themselves even as late as eighteen years after the infecting chancre. Later than this they are of greater rarity. Tabes and general paralysis are commonly much later in making their appearance than are the other neural lesions of syphilis, the average time being about ten years after the chancre.

Pathology.—Brain-lesions of syphilis may appear as areas of sclerosis or of softening and atrophy, or gummata may develop. In either case the pathology is the same. There are cellular proliferation and formation of vascularized granulation-tissue, usually diffuse in the case of the central nervous system and its membranes, and ultimately resulting in atrophy and sclerosis. Exceptionally cellular proliferation is circumscribed and extensive, forming gumma. Associated with these changes, or developing independently of them, syphilitic arteritis is a prime factor in the causation of brain- and cord-lesions.

Gummata are formed with far less frequency in the cerebral tissue proper than in the bones of the skull, or in the meninges or the subarachnoid space. When they form, however, they assume the same general appearance as elsewhere. They are seldom smaller than a pea or larger than an egg, are very consistent, with a caseous dry core, and are surrounded by highly vascular cerebral tissue containing numerous embryonal connective-tissue cells.

Gummata are commonly found in groups of three or four; these may be single or multiple. Although they may be found throughout the brain, they usually grow from the dura mater or the arachnoid membrane at the base of the cerebral hemispheres near the pituitary body, or on the convexity about the frontal convolutions.

It is at times extremely difficult to distinguish a large tubercle of the brain from gumma. The symptoms will be the same. An autopsy shows the tubercle as a somewhat regular and sharply defined tumor, with no extensions into the surrounding tissue, frequently exhibiting miliary tubercles about the periphery, and at times having undergone almost complete caseous degeneration. These are characteristics never observed in gummata. Tubercle is found far more frequently in the young, and is usually associated with deposits elsewhere in the body. Nowhere else, however, have these two lesions such similarity as in the brain.

Gumma-formation in the brain is not a rapid process; it increases slowly up to a certain point, and then remains a long time stationary unless by its size the gumma occludes blood-vessels and thereupon sets up a passive hyperæmia or ischæmia with consequent softening, which is the natural tendency of all such neoplasms. Under antisyphilitic treatment, however, gummata may be apparently absorbed, or at least checked, and then, not infrequently, a post-mortem discloses on the surface of the brain characteristic cicatrices or depressions, which are the remains of the preëxisting gummata, of which the patient had been apparently cured for many years.

Intracranial syphilitic processes never involve the entire tissue wherein they are situated, but are apt to develop from several foci situated on any of the intracranial tissues. They seldom attain a large size, and even the pseudo-membranous patches of the dura mater, or gummatous pachymeningitis, never cover completely the surfaces of the membrane over the hemispheres, wherein they differ from the ordinary congestive and inflammatory processes.

Syphilitic processes in general are far more frequently found on the surface of the brain and in the meninges than deep in the cerebral substance. Their most frequent seat is on the frontal portions and on the base of the brain in the sphenoidal region.

In addition to the gummatous and sclerotic lesions, which are the direct product of syphilis, there are lesions dependent on inflammatory or ischæmic processes—the sequelæ of syphilitic endarteritis. This endarteritis brings about a narrowing of the calibre of the vessels, producing a lessened blood-supply and consequent interference with function. As this narrowing increases, thrombosis may occur, with complete obliteration, in consequence of which, if the vessel affected is a terminal artery, the portion of the brain supplied by this vessel degenerates. When the basilar arteries are involved, the free collateral circulation prevents any symptom, even though the process has advanced to thrombosis. From this clot, however, an emblous may be loosened, which will produce the same symptoms as cerebral embolism occurring in the course of any other disease. The degeneration of the arteries, whether caused by syphilis direct or by the proximity of syphilitic lesions, is perhaps the most important factor in the cerebropathies of syphilis, particularly in regard to softening and hemorrhages.

When syphilis attacks the bones of the skull there may be cerebral symptoms, caused either by an actual infection of the brain or by a mechanical compression arising from a gummatous formation or by the presence of pus between the bones of the skull and the dura mater. It is rare that the brain-substance at the point of the osseous lesion is not affected.

In the patches of chronic syphilitic pachymeningitis there is little to characterize as specific; in all respects they resemble patches of pachymeningitis produced by any other cause. When situated on the upper surface of the membrane these sclerotic patches can involve large areas without giving rise to appreciable symptoms, but when situated in the membrane surrounding the canals of exit of the nerves they become highly dangerous.

Gummata of the dura mater may occur on either surface of that membrane, and are round, of firm consistence, sometimes a little soft, almost never liquid. One or more may be present, from the size of a millet-seed to that of an egg; they are grayish in color, with a firm centre. The adjoining nerves are atrophied, and the arteries may be not only obstructed by compression but invaded by the gummatous material, or even obliterated. Obliteration of the carotid, middle meningeal, and basilar arteries has been noted. In a case of gumma of the tentorium cerebelli all the sinuses bordering on the torcular Herophili were obliterated (Dowes).

Syphilomata of the arachnoid alone are rare, and appear as opalescent spots more or less thickened. They are either diffuse or grouped in compact masses in the centres of which are gray degenerations. True gummata are very rarely found.

The pia mater is the cranial tissue wherein the development of syphilitic meningitis is by far the most frequent.

From this membrane the greater part of the sclerotic and gummatous changes start, subsequently invading the encephalon. The lesions are more often of a fibro-cellular character than gummatous, and assume the form of plates or bands, following the course of vessels, most frequently along the edge of the fissure of Sylvius. They consist merely of opalescent patches, with a slight thickening of the membranes. Their tendency to extend along the vessels or

nerves often produces symptoms of circumscribed ischæmia and cerebral malnutrition, as well as neuralgias and paralyses of certain nerves. The motor nerves of the eye and the fifth pair are most liable to be thus affected.

The postmortem appearance of these lesions shows a close union of the membranes of the brain, with perhaps a slight adhesion to the cerebral cortex. True gummata in the pia mater are not quite so common as in the dura; they may attain large size. They are most frequently found in the frontal regions and at the base of the brain near the sella turcica. Small gummatous nodules also form along the arteries, and impinge not only on the brain but on the arteries themselves, at first obstructing their lumina and afterwards obliterating them, thus producing ischæmia of the brain.

The arteries of the brain are always more or less implicated. When they are themselves the seats of syphilitic degeneration they influence the nervous system directly by means of aneurismal dilatation or by hemorrhages which press upon the brain-substance. Indirectly, syphilis of the arteries can affect the brain by narrowing the lumen of the vessels and by destroying their elasticity, thus cutting off the blood-supply; all the symptoms of cerebral ischæmia thereupon follow. A thorough postmortem microscopical examination is sometimes required to reveal the numerous military aneurisms along the smaller arteries and capillaries or the obliteration of these vessels.

Syphilis, then, may attack the brain in the form of:

1. Diffuse gummatous infiltration of the meninges, with extension to the brain-substance.

2. Gummata, or circumscribed tumors.

3. Endarteritis, with its concomitant brain-lesions.

Symptomatology.—An examination of the symptoms of syphilis of the cerebrum and of its envelopes must include all known symptoms. But, while there exists no one pathognomonic sign to serve as a guide, there are, nevertheless, groups of symptoms, subjective or objective, which are fairly distinctive.

In general, syphilitic neuroses are characterized by multiplicity and incoördination of symptoms of either gradual or rapid development.

Except headache, disturbances of sensation, whether neuralgias or anæsthesias, are not commonly due to syphilis when they predominate over the other symptoms. On the other hand, disturbances of motility are frequent. Cerebral syphilis will inevitably, sooner or later, if left to itself, develop a paralysis or paresis. The neurosis may be at first revealed by epileptiform convulsions, but eventually paresis sets in, together with symptoms of cerebral degeneration, rapid loss of memory, and weakened cerebration.

As a prodromal symptom headache is chiefly characteristic. This varies greatly in intensity. It is worse at night, and is usually constant, is deep-seated and extremely harassing, and is accompanied by a certain failure in mental power, a lack of ability to concentrate the attention, and a condition of nervousness characterized by foreboding and a marked excitement from trifling causes. When there is meningitis of the convexity, tenderness to pressure or percussion may be noted. There are often vertigo, insomnia, and profound mental depression.

When the syphilitic process is circumscribed, as in the case of a gumma

or of an aneurism due to syphilitic arteritis, the pain is restricted to a limited area, and is described as like that of a nail being driven into the head. When patches of sclerosis are extensive, the cephalalgia may cover all one side of the head.

Aside from syphilitic affections of the brain and its meninges, the pain may be due to lesions of the cranial bones, or may develop as bone neuralgia.

Syphilitic neuralgias are characterized by pain located in the trunk or branches of distribution of a given nerve, and are aggravated by pressure along the course of this nerve, particularly at its point of emergence from the bone. This pain most frequently attacks the fifth pair, and has for its type supraorbital neuralgia. It is observed during the early stage of the secondary period—that is, in the first six or eight months of the disease. When it occurs during the tertiary period it is nearly always due to a distinct infiltration; sometimes it is caused by the pressure of a gumma or bony outgrowth. These specific neuralgias exhibit the symptoms characteristic of neuritis. They have, however, a tendency to become worse at night, and yield promptly to specific treatment. The therapeutic test is the only means of making a positive diagnosis.

Pain due to bone-involvement may occur in the early stages, during the height of the disease, or at a late tertiary period. It is most frequent in the tertiary period, and is then readily recognized, since the lesions are gross, producing considerable deformity.

Secondary lesions are slight, circumscribed, and readily overlooked, especially when they develop beneath the hairy scalp. They are characterized by circumscribed areas of hyperæsthesia without appreciable infiltration and are common in women.

The periostitides produce slight circumscribed swelling of the bone, particularly in the parietal, temporal, and frontal regions. The involved areas are small—about the size of a ten-cent piece, sometimes as large as a fifty-cent piece—very slightly raised, sometimes obscurely fluctuating. There may be true bone proliferation. They are painful and extremely sensitive. This excessive sensibility is a characteristic sign.

The ostealgias are characterized solely by pain and tenderness. There is neither swelling nor appreciable alteration of any kind. The pathological basis of this symptom is unknown. The pain is sometimes agonizing, and often radiates over a large surface.

Headaches due to syphilitic affections of the brain or its envelopes are more diffuse and more deeply placed than those dependent upon bony lesions or upon neuralgias.

Secondary syphilitic headache, which develops during the early periods of this stage of the disease, is common, especially in women; untreated it is usually severe and prolonged. It is severe in the regions of the forehead, the temples, and the occiput. The pain may be described as a feeling of weight in the head, or a beating, or a sense of pressure; sometimes it is lancinating or tearing, as if the cranium were about to burst. The pain varies greatly in intensity; it may be slight, bearable, not interfering with the pursuits of life; or as severe as an ordinary migraine, preventing work, particularly that requiring much thought, and disturbing sleep; or agonizing and absolutely unbearable.

Associated with the headache there are usually diminution of appetite, disordered digestion, general malaise, nervous erethism, great excitability, and sometimes disturbance of vision, with vertigo. The patient becomes morose, melancholic, stupid, and forgetful.

These headaches may assume the intermittent type or the continuous type with exacerbations. The intermittent type is most frequent, especially in the slight forms and those of medium severity. The pain usually comes on at about five or six o'clock in the evening and disappears during the night, often recurring at the same hour and in the same form day after day and following the same course.

The continuous type with exacerbations is less frequent. In these cases the headache never disappears entirely; but here again the exacerbation is observed in the evening or during the night.

In some cases these secondary headaches disappear in a few days or one or two weeks. Usually they persist for several weeks, or even for several months.

Diagnosis.—The diagnosis is founded on the nocturnal exacerbations and the prompt, characteristic, and extraordinarily curative effect of specific treatment. Night exacerbations of cephalalgia are not confined to syphilis. From the symptoms alone these headaches cannot be distinguished from those of anæmia, of hysteria, or of rheumatism. Fortunately, syphilitic headache is commonly associated with other incontestable signs of disease or with a history which is suggestive. Usually there are syphilides or alopecia and articular pains. In the rare cases where both history and concomitant symptoms of syphilis are wanting, an elimination of other causes of cephalalgia would suggest syphilis and consequently specific treatment. Thus, neuralgic cephalalgia would be distinguished by pain referred to certain points along the course of nerves; migraine, by comparatively long periods of remission; rheumatic cephalalgia, by superficial, muscular pain, increased on contraction of muscles, and relieved by heat; anæmia cephalalgia, by the facts that it lessens during the evening, that it is made better by eating, and that it is accompanied by other symptoms of lessened hæmoglobin; neurasthenic cephalalgia, by its less severe pain, its partly diurnal character, and its long continuance.

Treatment.—The specific treatment of secondary cephalalgia is attended by prompt results. Full doses of potassium iodide should be a part of the treatment.

Prodromal Cephalalgia of Tertiary Lesions.—The most important variety of specific migraine is that preceding the grosser symptoms of cerebral syphilis. In certainly two-thirds of all cases of hemiplegia, amnesia, aphasia, epilepsy, coma, pseudo-paralysis, etc., dependent upon syphilis, there is this prodromal headache. A large percentage of these cases could have been saved from these grave accidents by vigorous treatment instituted during the prodromal period.

This headache differs from other cephalalgias, as, for instance, those due to neuralgia or to epicranial rheumatism, in the fact that it is felt to be deep within the head. The character of the pain varies: 1, there may be simply a sense of weight and hebetude; 2. there may be a constrictive pain, as though the head were screwed in a vise; 3, the sensation may resemble that produced

by blows of a hammer, the suffering being intense and the pain deeply placed. These three types may be associated or may succeed one another.

The pain may be sharply circumscribed to an area not larger than a half-dollar. In this case it frequently indicates the formation of a gumma. Sometimes it is diffuse, occupying a general region, as the frontal, temporal, parietal, or occipital, or is spread over two or more of these regions. Exceptionally it seems to involve the whole head. The fronto-parietal region is the one to which this pain is most frequently referred. This form of cephalalgia has three characteristics which should at least strongly suggest its nature: 1, there is an habitual intensity, sometimes extraordinary severity, of pain; 2, it is persistent, tenacious, long-lasting; 3, there are nocturnal exacerbations.

Even in mild cases the pain is less bearable than the ordinary headache; it harasses the sufferers, making them despondent, morose, excitable, and sleepless, and interferes with general nutrition; or it may be so severe as completely to prostrate them. Exceptionally the pain amounts to a veritable anguish, comparable in intensity to that of hepatic or nephritic colic.

As a rule, syphilitic cephalalgia precedes the grave developments of brain-syphilis by an interval of from three to six weeks; it is, however, not uncommon for this pain to last from three to six months; exceptionally the pain may exhibit remissions and exacerbations for two or three years. Under the influence of intermittent mild specific treatment the headache may be temporarily cured, to recur time after time, till symptoms such as hemiplegia or epilepsy show that irreparable damage has been done.

Nocturnal exacerbations of pain, though the rule, are by no means invariable. In the secondary period this characteristic is most pronounced; in the tertiary period it may be wanting entirely; indeed, there may even be nocturnal remissions.

Treatment.—The treatment should be instituted early, and should be sufficiently thorough to cure the headache and to eradicate as far as possible the underlying constitutional taint. Mercury and potassium iodide should be given in the most active manner possible. Daily hypodermic injections of corrosive chloride or inunctions of mercury ointment should be given in full doses supplemented by the vapor bath. The use of salvarsan should be postponed till a thorough course of mercury has been given. Internally, potassium iodide should be rapidly pushed to the extreme point of toleration: to a woman, one to one and a half drachms a day; to a man, nearly twice this dose. This treatment should be long continued, with appropriate short intervals of rest, until there is good reason to believe that there is no likelihood of recurrence. Fournier has relieved the agonizing cephalalgia of high tension by lumbar puncture.

Parasyphilitic Cephalalgia.—Among the parasyphilitic headaches may be mentioned the neuralgic migraine and the crises of pain often observed in tabes. The most important cause of these headaches, and by far the most common, is neurasthenia. This is an ordinary sequel of syphilis, and among its multitudinous symptoms none is more troublesome or more frequent than headache.

This parasyphilitic neurasthenic headache is characterized by moderate in-

tensity; it is not really a pain, but rather a sensation of weight or constriction, of dulled or imperfect cerebral action. It usually lasts several years. It is present in the morning on rising; is sometimes better after meals, but shortly returns with its original intensity, or even with a slight excess of this; it is better at night, so that sleep is not disturbed. It is not benefited by specific treatment; it is usually located in the occipital region; and it is often associated with other signs of neurasthenia. These are characteristics which sufficiently distinguish this cephalalgia from pain preceding the recognized cephalopathies; indeed, a headache which has lasted for several years almost certainly does not belong to the latter class, since apoplexy or some one of the serious symptoms denoting irreparable brain-lesion is certain to develop long before the expiration of this period. Yet it may well happen that a differential diagnosis cannot be made. In this case the mixed specific treatment should be given one thorough trial. Should it fail, there should be no further effort in the direction of attempting cure by this treatment.

When the diagnosis of parasyphilitic neurasthenia is firmly established, minute attention to general hygiene, thorough hydrotherapy, especially with douches of brief duration, and congenial surroundings, represent the best methods of accomplishing a cure. The only drug which is of the least service, aside from tonics and nutritives, is potassium bromide; this sometimes relieves the headache.

But we cannot affirm that all grave syphilitic cerebropathies are preceded by these headaches. Mauriac quotes a case in which a man aged twenty-two was suddenly seized with severe convulsions of the left arm, which were undoubtedly due to syphilis, but which were preceded by no prodromal headache or other nervous symptoms. Fournier also has noted a similar case wherein the patient had suffered no headache during the ailment, and yet the post-mortem disclosed extensive syphilitic disease of the brain.

Following these prodromal symptoms there are certain symptoms, which Finger classifies as follows:

1. Psychical disturbances, with epilepsy accompanied by paresis not involving the cerebral nerves, terminating in coma. In these cases gummata and widespread endarteritis of the convexity of the brain are found.

Following the prodromes or without symptoms there is a sudden, often violent, epileptic attack, sometimes not accompanied by complete loss of consciousness. This is followed by cerebral irritability and fatigue, mental failure, progressing to dementia, localized muscular weakness, paresis or paralysis which may be of irregular distribution, and slow, halting speech.

2. Apoplectic attacks followed by hemiplegia associated with somnolence, with symptoms of irritation of one side and paralysis of the cerebral nerves.

In these cases there are gummatous infiltration of the base and arteritis involving the vessels of the large central ganglia. Following prodromal symptoms there is suddenly developed palsy of one or more cranial nerves, the oculomotor and abducens being most frequently involved. This will be shown by ptosis, strabismus, loss of accommodation, etc. These palsies are persistent, and may be preceded or accompanied by twitchings or contractions of the muscles supplied by the affected nerves. Following these symptoms, or sometimes pre-

ceding them, there is an apoplectic attack, often not attended by loss of consciousness, but with hemiplegia and disturbance of speech. Even when this stage is reached almost complete restoration of mental power is possible. If the disease is progressive, other apoplectic attacks supervene, the mind becomes dull and listless, there are involuntary micturition and defecation, and finally coma and death supervene.

3. Psychoses, appearing generally in the form of paralytic dementia or progressive paralysis.

These psychoses are usually accompanied by paresis or paralysis, especially of the cranial nerves, and by epileptiform attacks.

The syphilitic cerebropathies are most commonly characterized by a slow but steady advance; thus, a slight neuralgia expands into epileptiform convulsions, and finally ends with paresis or paralysis.

Diagnosis of Intracranial Syphilis.—In general it may be affirmed that all non-traumatic, non-cardiac cerebropathies found in persons of previously good health between the ages of twenty and forty are probably of syphilitic origin. If there is a history of preceding chancre the diagnosis is still further assured. Epilepsy, if idiopathic or inherited, always makes its appearance in childhood; when it occurs late in life and is non-traumatic, it is exceptional, and is then probably due to syphilis. In nervous disorders wherein two diatheses are possible causes, for instance, the gouty and the syphilitic, the diagnosis is to a certain extent dependent upon the therapeutic test.

A gouty diathesis is apt to produce nervous symptoms only late in life, but in all other respects gouty and syphilitic cerebropathies may be almost identical. In both gout and syphilitis arterio-sclerosis is a common feature, and the same symptoms would follow from whatever cause the lesion was produced.

Even the therapeutic test is not wholly trustworthy in deciding as to the specific nature of palsies. Paralysis of the facial nerve, though strongly suggesting syphilis, is not pathognomonic, since facial paralysis may be produced by cold, and may be only a transitory affection, which disappears under full doses of potassium iodide simply because it has run its course. It is always possible that the paralysis may have been an independent acute attack, and might have disappeared of itself without treatment.

Attention has been called to the fact that the symptoms of cerebral syphilis are often attributed to slight disorders, and hence treatment is not instituted at the time that it is most valuable.

In forming a diagnosis a minute study of the previous history is imperative, as well as careful observation of the entire symptom-complex. The diagnosis will then be founded on a syphilitic history, a prodromal headache persistently worse at night, and often associated with vertigo, impaired mental activity, localized paresis, epileptiform or apoplectiform attacks, not necessarily attended with loss of consciousness, hemiplegia and paralysis particularly involving the cranial nerves, marked psychoses, and coma. These symptoms are somewhat irregular, but progressive. They are checked by specific treatment. Vertigo is of significance only when associated with headache; it is aggravated by excitement or sudden change of posture, and may merge into transient unconsciousness. Insomnia is the rule in patients under fifty, who are often unable

to sleep at all during the first part of the night. This insomnia bears a relation to the intensity of the headache, and disappears with the latter on the onset of paralysis. Somnolence is observed in patients over fifty.

The paralysis that develops during sleep is probably due to a thrombus, that which occurs during brain activity is probably caused by rupture. Involvement of the third nerve is so characteristic of intracranial syphilis that ptosis or strabismus developing suddenly in an adult is diagnostic. Epilepsy developing in the adult is traumatic, uræmic, or syphilitic, and hemiplegia, if not embolic, is usually of the same nature.

Examination of the blood-serum and of the cerebrospinal fluid results in more or less suggestive findings in the majority of the cases. The serum Wassermann is more frequently positive than that of the fluid (81 per cent. to 66 per cent.). A pleocytosis is found in approximately 80 per cent. of cases, and an increase of globulin with about the same frequency. The Lange gold test has been found to give a luetic curve in 60 per cent., a paretic curve in 13 per cent., and a normal reaction in 27 per cent. (compilation of Miller, Brush, Hammers, and Felton).

Prognosis.—The prognosis is always grave unless energetic anti-syphilitic treatment can be instituted before the syphilitic lesions have produced actual destruction of nerve tissue from pressure incident to involvement of the neuroglia and adventitious tissues. In most cases a guardedly favorable prognosis can be based on a prompt response to specific treatment. Meningitis, gummatous tumors, many cases of myelitis and paralysis due to thromboses or to endarteritis obliterans, offer a prognosis much more favorable than do these same conditions when due to other causes. Locomotor ataxia is sometimes apparently made worse by specific treatment. Syphilitic epilepsy in its earliest stages may be helped by treatment; later, because of habit, the cause becomes of minor importance so far as cure is concerned; moreover these patients are often intolerant of iodides. The prognosis is general paralysis of the insane, and is almost invariably hopeless; certainly nothing positive can be promised as to the final outcome.

In a large proportion of the cases of intracranial syphilis, the lesion is an endarteritis obliterans. Before the obstruction is complete, much can be done by active treatment.

Treatment.—The treatment for cerebral syphilis is the same as that for all tertiary lesions—namely, a mixed treatment of potassium iodide and mercury. The potassium iodide should be started in full doses of thirty to forty grains daily and pushed rapidly to the point of tolerance. Everything depends upon obtaining a prompt action, and to begin with small doses of five or six grains is a dangerous waste of time. The use of salvarsan should be preceded by such a course of treatment. The prodromal period is the time to avert irremediable degenerations and to ward off the violent nerve-storms which are sure to follow if the treatment be neglected. Hygienic measures are not to be ignored, the nervous system must be kept at rest, there must be no household or business worries, and there must be, if possible, moderate and regular exercise. Attention to the digestive tract is of the utmost importance.

In convulsive types the bromides are useful; antipyrin, chloral, and chlo-

ralamide are at times of great service when the pains are intense. Electricity should be employed to exercise and stimulate the paralyzed muscles. When rapid action of the specific is imperative, intramuscular injections of mercury are indicated. Potassium iodide is most conveniently given in the saturated solution of which one minim contains one grain. The limit of physiological toleration to these drugs should be reached early and maintained by full doses.

SYPHILIS OF THE SPINAL CORD

Syphilis of the spinal cord cannot be said to have in its symptoms the irregularity and incongruity which are the characteristic features of cerebral syphilis. Myelopathies due to syphilis correspond in every respect to those due to other causes. Syphilis, however, is an etiological factor of the greatest frequency in all myelopathies, whether distinguished by softening or by sclerosis, either diffuse or circumscribed: so that it is almost justifiable to assert that any myelopathy of which the cause is not manifest is syphilitic.

The syphilitic lesions which may affect the cord and its membranes are identical with those which affect the brain—namely, diffuse gummatous infiltration followed by sclerosis, circumscribed gummata, and endarteritis. Myelopathies occur with the greatest frequency during the third or fourth year after infection; cases, however, have been observed occurring as late as twenty-five years after the contraction of syphilis.

Etiology.—There is no satisfactory explanation as to why syphilis should attack the cord in some cases and not in others. In addition to the general causes mentioned when treating of cerebral syphilis, venereal excess and, according to Mauriac, the influence of a damp cold climate should be included.

Morel-Lavallée thinks that there is special virulence in the original infecting germ of certain cases of syphilis which has a predilection for the nervous system. He cites from personal observation the cases of five men who contracted syphilis from the same source, and all of whom died, at varying periods after infection, from syphilitic disease of the nervous system, while, strangely enough, the woman who infected them married and gave birth to a healthy child. This special virulence he calls the " vérole nerveuse."

As a rule, syphilis does not attack primarily the essential tissues of an organ—as, for instance, the nerve-cells themselves: hence gummata of the cord are rare; they do occur, however, in the centre of the cord, and somewhat more frequently on its surface, adhering closely to the meninges, from which probably they originate. They present the same appearance as gummata of the cerebrum.

The most common forms of syphilitic myelopathies are sclerosis and softening, which are usually associated and which may be widespread or circumscribed. Softening often, not always, follows in the path of the sclerosis; it is only exceptionally a rapid process, and where symptoms of spinal disorder have existed for a length of time is commonly found in disseminated patches. When the myelopathy has advanced rapidly and deep bed-sores form in the sacral region, the softening is generally extensive, without patches of sclerosis.

Fibrous degeneration or sclerosis of the cord is more frequent than softening,

but for the most part the two processes are so intimately associated that they may be considered as but two phases of the same process.

Lesions of the cord consequent upon syphilis of its bony envelope are far less frequent than are the corresponding cerebral lesions; possibly because of the greater space between the vertebræ and the nervous tissue, and also because the vertebræ have a periosteal envelope independent of the dura mater.

The meninges of the cord are especially liable to be attacked. The membranes are so intimately associated that it is almost impossible to distinguish in which of the three the lesion originated, since it always rapidly spreads from one to the other, thus making at the invaded point one thick membrane, possibly studded here and there with gummatous deposits.

Symptomatology.—The symptoms of myelo-syphilis present the same general characteristics as cerebral syphiloses—namely, dissemination of manifestations, a marked tendency to temporary amelioration, and recurrences, together with early implication of the bladder and rectum and the early development of bed-sores.

The development of symptoms due to compression of the cord by a syphilitic osteophyte is usually comparatively slow, but otherwise the same as from compression due to any other cause. When, on the other hand, syphilitic disease of the bone has gone to such an extent as to produce a sudden dislocation of the vertebræ, then symptoms arise as suddenly.

The paralytic and trophic symptoms vary according to the situation of the compression or degeneration. The cervical region is most frequently attacked, and if the compression is only slight the upper extremities alone will be affected. A point of tenderness can almost always be elicited on the spinal column opposite the lesion of the cord, and in a case of suspected cervical lesion an examination of the throat should always be made; there is a possibility that deep ulcerations may indicate disease of the vertebræ in this region.

Syphilitic meningitis is rarely of an acute type; it more commonly assumes the form of sclerotic patches or bands pressing on the cord, and is manifested in much the same manner as compression due to other causes. The dorsal and lumbar pains are of excruciating intensity, made worse by motion. Finally, paralysis of the extremities and sphincters supervenes, and indicates that softening or annular constriction of the cord has commenced.

Acute or subacute myelo-syphiloses are not as common as the chronic; they are most common in secondary syphilis. When they occur at a period long after the chancre, with no other manifestation of the disease, the diagnosis is extremely difficult. Vesical troubles and weakness of the lower limbs are usually the first symptoms, which rapidly advance to paralysis and retention of urine and fæces, followed shortly by incontinence and the formation of deep bed-sores on the sacrum and the heels. Fever, if any develops, is slight.

Treatment is of little avail, and death ensues in a few days or weeks. This acute myelo-syphilosis is the most dangerous of the syphilitic affections of the cord.

Chronic myelo-syphiloses are distinguished not so much by their duration as by the gradual development of symptoms. They are much more common than the acute forms, and less likely to have a rapid termination.

The first symptoms are usually overlooked, and consist of neuralgic pains, with weakness in the limbs. Slight difficulties of micturition and gradual enfeeblement of sexual power follow in order. The weakness gradually develops to paresis or paralysis, and the sexual power is entirely lost. The patient next suffers all the excruciating pains and girdle symptoms of myelitis. It is very rare for disturbances of sensation to keep pace with the paralysis. A part of the body entirely paralyzed may still retain its normal sensibility, or else the sensation may be merely blunted and the patient be unable accurately to localize the sensation. The reflexes are at first exaggerated, but soon become much diminished or abolished. The symptoms are usually confined to the lower extremities, and it is rare for the process to have a tendency to ascend the cord.

Under the influence of specific treatment the disease may be occasionally checked or even apparently cured; but it must be remembered that temporary ameliorations are characteristic of all syphilitic neuroses.

Tabes and General Paralysis of the Insane

Formerly these manifestations of syphilis were styled "parasyphilitic" or "metasyphilitic" affections, it being believed that they were due to various causes acting upon soil prepared by the syphilitic poison. They occur late, on an average ten years after the chancre; the patients usually bear no evidence of tertiary syphilis in the skin and bones (though the heart, aorta, and testicles are usually the seats of lesions recognizable with the microscope); and their course is influenced little by antisyphilitic treatment—sometimes the result of such treatment is distinctly unfavorable. However, the discovery of spirochætes in the lesions of both diseases has settled the question of their etiology, and shown that they must be considered as true syphilitic conditions.

Both tabes and general paralysis are degenerative lesions of the central nervous system, the dorsal columns of the spinal cord being attacked in one case, the cells of the cerebral cortex in the other. The closeness of their relationship is indicated by the frequency with which the two diseases are found in the same patient; Mott states that 10 per cent. of the fatal cases of general paralysis have well-marked sclerosis of the posterior columns of the spinal cord, while if careful microscopic examinations of the brains of tabetic patients dying in asylums be made almost all will be found to be tabo-paretics.

Tabes.—In its later stages tabes dorsalis (locomotor ataxia) is easily diagnosed even by the layman by its characteristic gait. In this stage of the disease there is very little to be done for the sufferer, the diagnosis, therefore, being of about as much value as there is difficulty in its making. However, the marked ataxia which is such a prominent symptom in the later stages of the malady is not present at the beginning of the degenerative process, and inasmuch as, once degeneration has occurred, it is not possible for the nervous elements to be restored, it is of the greatest importance that the diagnosis be made with all possible dispatch.

One of the earliest signs of tabes is the change in the pupillary reaction known as the Argyll-Robertson pupil. This consists in a loss of the normal reflex contraction to light, while the power of contraction with accommodation

and convergence is still maintained. This combination has been noted but rarely except in tabes and general paralysis of the insane. The typical reaction is found in over 70 per cent. of cases, while in the majority of the remainder there are such pupillary abnormalities as unilateral Argyll-Robertson reaction, sluggishness to light, and complete immobility (Mott). It is also common to find that the pupils are irregular in shape and of unequal size. Unfortunately, these are not symptoms which the patient is likely himself to observe, so they are only recognized when the disease is suspected for some other reason, in the course of a careful routine examination.

Usually patients apply for treatment because of pain in some part of the body, or because of failing eyesight, or because of trouble with urination, or because of impotence.

The pains of tabes are usually of a sharp, sudden, piercing character, often called "lightning" pains, and may be felt in any part of the body. The individual pains are usually of short duration, but the attacks last for hours or days. At other times the pain is a rheumatic ache. Girdle sensations are also frequently noted, as are paræsthesias, such as formication, pins and needles, and particularly a sensation in the soles of the feet as though the patient were walking on velvet. All disturbances of sensation from hyperæsthesia to complete anæsthesia and analgesia are encountered with great frequency. Anæsthetic areas usually appear first on the trunk, and commonly accompany gastric crises.

Blindness, partial or complete, is a fairly common and quite early symptom. Gradual peripheral diminution of the fields is the rule, due to degeneration of the optic nerve. It has been repeatedly observed that there is less tendency to develop ataxia in cases with early optic atrophy than in others; but there seems to be a greater tendency to develop general paralysis.

Of the visceral disturbances, gastric crises and abnormalities of bladder control are the most important. The former consist in lancinating pain in the region of the stomach, accompanied by vomiting. Cases are also seen in which there is pain without vomiting, and occasionally instances of vomiting without pain. Rectal crises, with severe tenesmus, are also of frequent occurrence. Intestinal crises, usually painless, but with numerous watery stools, are rarely seen. Urinary disturbances, chiefly difficulty in starting the stream, loss of projectile force, frequency of urination, and, later, more or less complete retention of urine, are of fairly frequent occurrence.

In the older cases there is loss of the sense of position of joints. This usually occurs first in the fingers and toes, later in the other joints of the extremities.

The ataxia which is responsible for the commoner name of tabes usually develops at a comparatively late date, often not till many years after the beginning of the degenerative process. It is usually found first in the lower extremities, and in many cases these alone are affected; incoördination is never observed in the muscles of the neck and head.

Loss of the deep reflexes is one of the earlier symptoms of tabes, often preceding ataxia by several years. The Achilles tendon reflex is usually lost before that of the patellar tendon, while loss of the triceps reflex is of still later

occurrence. While the loss of these reflexes is characteristic of the disease, their presence is not altogether incompatible with a diagnosis of tabes.

Prognosis.—Tabes dorsalis shortens life very little. It is typically a chronic process, extending over years, and often, even in the absence of all treatment, is stationary for long periods. There is, of course, no possibility of restoring the function of atrophied tracts; the most that can be hoped for is arrest of the degenerative process.

Diagnosis.—This rests in part on the symptomatology, in part on the physical examination, and in part on the laboratory findings, especially in the earlier cases. Schaller says: "In a patient with a history or other evidence of syphilis presenting characteristic sensibility disturbances of the radicular type, with a tendency to symmetry, one should suspect a potential or early tabes. If, associated with the above, we have a positive reaction in the cerebrospinal fluid, indicating a chronic syphilitic meningitis, together with such pupillary phenomena as anisocoria, pupillary irregularity, or sluggish reaction to light, the diagnosis of early tabes is most probable. Added to the above symptoms, the loss of the Achilles tendon reflex establishes the diagnosis of early tabes even in the absence of those signs which we usually associate with tabes: Romberg, marked sensibility loss, absent patellar reflexes, and Argyll-Robertson pupils." The usual laboratory findings in tabes are a positive Wassermann in both the serum (54 per cent.) and the cerebrospinal fluid (48 per cent.), an increase in the cell count in the fluid above 8, an increase in the globulin content, and a positive Lange gold test (luetic curve). None of these tests are invariably positive; the gold test is the most constant reaction. It must be remembered that the manifestations of tabes are very varied, and that exactly similar cases are never seen. The diagnosis must be made by careful consideration of the several symptoms presented.

General Paralysis of the Insane.—Spirochætes can be found in the brains of paretics with much more ease and regularity than in the cords of tabetics. They have been found in all parts of the brain, but most frequently and in greatest numbers in the gray matter of the frontal and limbic lobes. The organisms have been found both post mortem and during life; in the latter case the tissue for examination was removed by means of a needle thrust through a hole in the skull made with a dental drill. While syphilis has been repeatedly produced in the lower animals by inoculation with tissue from paretic brains, the percentage of successful results has been low, and the incubation period in the successful cases has been distinctly greater than when the source of supply has been primary or secondary lesions.

The anato-pathological basis of the disease is a progressive atrophy of the nervous elements starting and most prominent in the cerebral cortex, but being evident also in the advanced cases throughout the central nervous system. Moreover, there is evidence of meningeal irritation, particularly over the anterior portion of the cerebral convexity.

Clinically the disease is diagnosed with the greatest difficulty in its early stages, an indefinable change in the disposition and mental attitude being the only thing to indicate there is aught amiss. Later—often two or three years later—the development of delusions, especially ones of the grandiose type, and

of a progressive dementia, with the slurring speech, immobile facies, tremor (especially of the tongue and facial muscles), pupils which are immobile or sluggish to light, often irregular and unequal, makes the diagnosis evident. The knee-jerks are altered in most cases, usually exaggerated. After the development of well-marked dementia half of the cases die in six months, while most of the remainder succumb in less than three years.

The customary laboratory findings are a positive Wassermann reaction in both the serum (91 per cent.) and spinal fluid (90 per cent.), and the pleocytosis and globulin increase typical of a syphilitic meningitis. The Lange gold test gives a curve of the type 5555542100 (see Chap. XLIII).

SYPHILIS OF THE NERVES

At any period of the disease syphilis is liable to attack the nerves or the ganglia.

Syphilitic degeneration of the parenchyma of the nerve itself is rare; the process usually takes place in the network of connective tissue between the fibres and in the sheaths of the nerves. But wherever the lesion is situated in the nerve, the symptoms are virtually the same, and manifest themselves, as in other organic neuroses, by disturbances of sensation, motion, and nutrition.

The sciatic nerve is perhaps the most frequently affected, although any one of the nerves is liable to attack. The pains produced by these lesions are not to be confounded with the rheumatoid neuralgias which occur early in the secondary stage, and which are in reality only slight functional disorders and not the result of true neuritis; nor with the pain caused by small periosteal tumors, such, for instance, as those formed upon the sternum and the ribs.

The suffering caused by syphilitic neuritis is intense, and frequently accompanied by contractions of the muscles, paresis, and paralysis. The early sciaticas—those occurring at the beginning of the secondary stage—are readily cured by specific treatment, and rarely last more than a week or two; coming on later in the disease and accompanied by evidences of degeneration, they are much more serious, and are then probably due to sclerosis or gumma formation in the connective tissue and substance of the nerve.

In like manner neuralgias of the occipital and cervical nerves are of slight import in the early secondary stage, but when occurring in the tertiary period they are to be regarded as grave symptoms of disease of the cervical vertebræ.

Syphilis not uncommonly attacks the cranial nerves and the nerves of special sense. The lesions may be of the nerves themselves, or of their sheaths, or of their canals of exit from the skull; or the symptoms may be due to the presence of neighboring gummata.

In any event there will probably be paralyses or possibly contractions of the muscles which the involved nerves supply. Although the symptoms are the same as from neuritis dependent upon other causes, a history of syphilis affords sufficient justification for assuming that the lesions are specific and for treating them as such. If they occur at a period remote from other syphilitic manifestations they must be diagnosed by the method of exclusion or by applying the therapeutic test.

The earlier the symptoms of nerve-involvement appear in the disease the more favorable is the prognosis.

The optic nerve, according to Charcot, may be the seat of fibrous metamorphosis incident to parenchymatous neuritis. The lesion of the optic nerve is usually a phenomenon of late appearance, and depends more or less upon cerebro-syphiloses.

The sense of smell is affected when pachymeningitis of the anterior cerebral fossa causes pressure upon the olfactory lobes: it may also be impaired by extensive destruction of the bones and the mucous membrane of the nose.

In like manner the auditory nerve is affected either by central lesion or by the destruction of its bony envelope.

Of all the cranial nerves the motor oculi, or third pair, is the one most frequently affected. Paralysis of these nerves often makes its appearance early in the secondary stage, but is then only a transitory affection. When the lesion is deep-seated the symptoms will be ptosis, dilatation of the pupil, external strabismus, and paralysis of accommodation.

Possibly mydriasis may be the only symptom; this has been found to be the case when the lesion is situated near the lenticular ganglion and cuts off only the short ciliary branches of the nerve.

The fourth pair is rarely affected.

Lesions of the fifth pair are common, and are manifested by neuralgias or hyperæsthesias of any or all of its branches.

Affections of the sixth pair are rare; they are accompanied by diplopia, convergent strabismus, and orbital neuralgia.

The seventh pair of nerves exhibits a peculiarity in that it is so often affected early in the disease, at times within a few weeks of the appearance of chancre.

The symptoms vary according to the situation of the lesion: if it is situated on the main trunk of the nerve within the Fallopian canal, or beyond it, paralysis of the face is the only symptom; if it is situated within the skull, the usual symptoms of intracranial lesion—headache, vertigo, aphasia, convulsions, etc.—are also present.

The other cranial nerves are rarely affected.

CHAPTER XXXVIII

SYPHILIS OF THE EYE, EAR AND RESPIRATORY TRACT

Chancre may develop on the eyelid or on the conjunctiva. Beginning as a pimple, the lesion gradually develops into a characteristic, saucer-shaped ulceration, with rounded edges and indurated base.

Secondary syphilis may appear upon the eyelids, as well as gummata of the skin and so-called tertiary ulcers.

Syphilitic tarsitis is an inflammation of the tarsus, which produces great thickening of the lids, and in some instances is due to a diffuse gummatous infiltration. More rarely it is acute, and then must not be mistaken for an ordinary strumous inflammation of the ciliary border, from which it is to be distinguished by the thickening and induration of the tarsus.

Syphilitic conjunctivitis has been described in a few instances, the appearances being somewhat analogous to those of granular lids, the disease yielding, however, only to antisyphilitic remedies.

Syphilitic periostitis may attack the orbital margins either in a gummatous or in a sclerosing form. When the orbital walls are involved behind the capsule of Tenon, the type is almost always gummatous. The symptoms are then pain, worse at night, restriction in the mobility of the globe, squint, and diplopia. As complications there may be optic neuritis and inflammation of the cornea.

Caries of the margin of the orbit is not uncommon in syphilis, usually as the result of preëxisting periostitis.

Syphilis of the Lachrymal Apparatus.—Occasionally the lachrymal gland becomes enlarged and indurated as the result of syphilis, and hypertrophy of this body, appearing as an indurated lobulated tumor, having its situation in the upper and outer part of the orbit, should always be given careful antisyphilitic treatment before surgical measures are adopted.

Occasionally a lachrymal abscess forms in children above the internal palpebral ligament and external to the sac itself: hence the name prelachrymal abscess; it is usually due to inherited syphilis.

The lachrymal sac and nasal duct may become obstructed through periostitis and caries of the lachrymal bone or the pressure of gummatous deposits. The lachrymal apparatus in its entirety is singularly free from manifestations of syphilis.

Syphilitic Affections of the Cornea.—*Interstitial Keratitis* (syphilitic, inherited, specific, parenchymatous, or diffuse keratitis.)—This is a chronic inflammation of the whole thickness of the cornea, the membrane gradually passing into a condition of universal thick haziness, associated with vascularization, but almost always without ulceration.

Etiology.—Inherited syphilis is the cause in between sixty and seventy per cent. of the cases. Very rarely perfectly typical examples appear with acquired syphilis. It is described under hereditary syphilis.

Punctate keratitis, characterized by the deposition of opaque dots arranged in a triangular manner upon the posterior elastic lamina of the cornea, is usually an indication of affections of the iris, choroid, and vitreous, but may also appear both with and without iritis, and as a syphilitic inflammation. It occurs in the late or gummatous period of syphilis, but is seen also in children before puberty as one of the forms of inherited syphilis. The treatment is the same as that described under interstitial keratitis.

Syphilis of the Sclera.—A certain number of cases of scleritis and episcleritis—that is, inflammation of the sclera itself or its overlying tissue—have been ascribed to acquired syphilis and yielded to the ordinary remedies. So, also, in the late stages of syphilis, a true gummatous scleritis may develop, characterized by the formation of yellowish-brown and semi-translucent nodules on this membrane.

Syphilis of the Iris.—Fifty per cent. of all cases of iritis are syphilitic, and are frequently associated with choroiditis.

There are four distinct varieties of the affection.

1. **Syphilitic Plastic Iritis.**—This may occur in the early stages of general syphilis, usually between the second and the ninth month after the initial lesion, and is characterized by the ordinary symptoms of iritis—namely, fine pericorneal injection, contracted sluggish, or immobile pupil, discolored iris, abnormal reaction to a mydriatic, slight tenderness on pressure, the formation of attachments between the margin of the iris and the capsule of the lens (posterior synechiæ), and severe pain in the brow and head, worse at night.

The symptoms do not differ from those of a simple iritis from other causes, and are of themselves not characteristic of the disease, yet the lesions are due to the syphilitic taint and yield to the ordinary constitutional remedies and local measures.

2. **Syphilitic parenchymatous iritis** is an accompaniment of secondary syphilis, and is characterized by a deposit of yellowish-red nodules on the ciliary or the pupillary border of the inflamed iris, comparable to the papules and condylomata of the stage at which it occurs, and hence called iritis papulosa or condylomatous iritis. These small nodules vary in number from one to four, and are gradually absorbed under treatment, leaving faint scars in the iris-tissue to mark their former situation. Sometimes instead of distinct nodules there are local swellings in the iris-tissue, the membrane being attached at these situations by broad and moderately soft synechiæ to the capsule of the lens, causing fixed distortion of the pupil, often "umbrella" iris, and impairment or loss of vision.

3. **Gummatous iritis**—gumma of the iris—occurs in the late or tertiary stages of syphilis, and is characterized by the development of large yellowish nodules, usually on the ciliary border of the iris, and strongly analogous to gummata elsewhere in the body.

Occasionally at this late stage an iritis unassociated with nodules appears, somewhat resembling the plastic type of the disease, and probably the relapse of a plastic iritis which occurred in an early stage, owing to a failure in the absorption of the original synechiæ.

4. **Serous iritis** (more properly, serous cyclitis), characterized by a serous or sero-plastic exudate, deepening of the anterior chamber, slight dilatation of

the pupil, haziness of the cornea, and opaque dots on its posterior elastic membrane arranged in a triangular manner, is an unusual variety of iritis as the result of acquired syphilis in the secondary stage, although common from many other causes.

Inherited syphilis may also produce iritis, the disease, characterized by much exudation and rapid occlusion of the pupil, usually appearing between the ages of two and fifteen months, and being very much more frequent in girls than in boys. It is probable that all iritis occurring in young children is due to syphilis.

Subacute, chronic, and so-called quiet iritis may also be caused by syphilis, the latter, as its name implies, being unassociated with much pain or ciliary congestion, the progressive dimness of vision usually leading to its discovery.

Prognosis.—The prognosis of the various types of syphilitic iritis is good, provided the cases are seen early, before firm adhesions form and much exudation pours out into the pupillary space, causing either its occlusion or its exclusion. When thoroughly treated, relapses are infrequent. Commonly both eyes are attacked, one a little later than its fellow; occasionally the onset is simultaneous.

Treatment.—This should consist in the free use of atropine drops, four grains to the ounce, hot compresses and leeching the temple to relieve pain and enhance the action of the atropine, and the persistent use of such antisyphilitic remedies as are indicated by the stage at which the iritis appears. In stubborn cases, and especially in gummatous iritis, subconjunctival injections of bichloride of mercury may be used with benefit. Success depends upon beginning the treatment early enough to tear loose the synechiæ by the use of atropine, which, except in the cases of serous iritis where there is a tendency to rise of intra-ocular tension, must be vigorously used until all signs of irritation have passed away and a perfectly round pupil is obtained.

Syphilis of the Ciliary Body.—Independently of the fact that this structure is commonly involved in all the severe types of inflammation of the iris, forming the so-called irido-cyclitis, and that serous iritis is really a manifestation of inflammation of the ciliary body, syphilis strictly confined to this structure is uncommon. In a few instances, however, gummata thus located have been described.

The treatment of cyclitis of syphilitic origin, or, more properly, irido-cyclitis, does not differ from that of iritis.

Syphilis of the Choroid, Retina, and Optic Nerve.—The most important lesions of these structures, discoverable only with the ophthalmoscope, are the following:

Deep choroiditis, characterized in its diffuse exudative variety by yellowish-white plaques, going on later to absorption, heaping of pigment, and atrophy of the retina (choroido-retinitis), and in its disseminated variety by the formation of numerous round and oval spots in the fundus oculi, which have a characteristic punched-out look and the margins of which are bordered with black pigment. In the later stages opacities in the vitreous humor are common, and atrophy of the optic nerve may take place. Vision is often seriously affected, especially if the region of the macula is involved.

The various types of choroiditis which are due to acquired syphilis appear

from six months to two years after the initial lesion; sometimes ten years elapse before their appearance.

Choroiditis of similar type may be due to inherited syphilis, and develops between the sixth month and the third year of life. The treatment consists in the exhibition of the usual antisyphilitic remedies. Subconjunctival injections of sublimate are said to be especially efficacious.

There are a number of other types of choroiditis which probably depend upon syphilis, but that named is the most important.

Syphilitic retinitis occurs in various types. The first variety, ordinarily called choroido-retinitis, is really a disease of the choroid. The most important symptoms are opacity of the vitreous (syphilitic hyalitis), usually in the form of dust-like particles; loss of transparency of the retina around the head of the optic nerve, which is unduly hyperæmic; and numerous yellow or white spots of exudation bounded by pigment lying beneath the vessels of the retina. Vision is much affected, especially in dim lights, the field of vision is contracted, and the patient complains of shimmering, spots, circles, dancing lights, and distortion of objects.

Sometimes the disease is more truly located in the retina, which becomes affected with a gray opacity, the optic nerve entrance being yellowish red in color, while floating opacities arise in the vitreous; occasionally there are hemorrhages.

Of an unusual type and one belonging to the late manifestations is a central retinitis, located largely in the macular regions, and characterized by the appearance of numerous yellow or yellowish-white spots and pigment-dots.

Retinitis may occur both in congenital and in acquired syphilis. In the acquired form it appears usually from one to two years after infection, but sometimes as early as the sixth month. Generally both eyes are involved.

In the hereditary disease it arises, like choroiditis, between the sixth month and the third year of life.

The treatment consists in the exhibition of the ordinary antisyphilitic remedies, which should be vigorously pushed in order to prevent secondary changes in the optic nerve and consequent blindness. The eye should be protected with dark glasses, and the accommodation paralyzed with a weak solution of atropine.

Syphilitic optic neuritis, characterized by swelling of the nerve-head, distention of the veins, which become darker in color and tortuous, and hemorrhages upon the swollen papilla or in its immediate neighborhood, may be caused by the formation of an intracranial product, for example, a gumma, or may develop as an essential sign of syphilis.

Rapid mercurialization should be practised, to be followed later by the iodides, and if the exudation is quickly absorbed the prognosis as to vision may be good; otherwise the tissues are strangled, and there results—

Atrophy of the Optic Nerve.—In addition to this consecutive atrophy of the optic nerve the result of a syphilitic neuritis, a primary atrophy occurs, observed in tabes dorsalis.

The usual symptoms of optic nerve atrophy are progressive loss of vision, ever-increasing restriction of the field of vision, and the ophthalmoscopic appearances of atrophy—namely, pallor of the disk, absence of capillaries, and shrinking of the size of the vessels.

Syphilitic Palsies of the External Ocular Muscles.—The most frequent cause of paralysis of the external ocular muscles is syphilis, fully one-half of the cases having this origin. The usual lesion is an inflammation or gummatous change affecting the nerve at the base of the brain, or in the orbit, or there may be disease of the nuclei of the nerves or of the brain in their immediate vicinity, or, finally, the lesions may exist in the third ventricle, in the aqueduct of Sylvius, or in the fourth ventricle. Syphilitic paralysis is usually but not always one of the late manifestations of syphilis. The oculo-motor nerve is the one most frequently affected. The involvement is often a forerunner of tabes or general paralysis.

In rare instances there is paralysis of the ocular muscles as the result of inherited syphilis.

The usual symptoms of palsy of the ocular muscles are present—namely, double vision, strabismus, limitation of movement in the direction of the affected muscles, vertigo, and an altered position of the carriage of the head, which is apt to be turned in the direction in which the patient is least troubled by the double images.

Ophthalmoplegia is a term used to characterize a loss of power in one or more of the eye-muscles, which gradually increases and involves other muscles until all of them may be paralyzed. This may be caused by hereditary and also by constitutional syphilis.

In addition to the paralysis of the external muscles of the eye there are various conditions of the pupil and ciliary body which arise under the influence of syphilis; thus, if the oculo-motor is paralyzed and those branches which supply the iris and the ciliary body are affected, there will be dilation of the pupil and loss of accommodation. Occasionally there is a wide dilatation of one pupil without affection of the ciliary body, and inequality of the pupils may arise in the course of a focal syphilitic brain-lesion. The treatment of these ocular palsies, both external and internal, demands the use of mercury and ascending doses of potassium iodide.

SYPHILIS OF THE EAR

The auricle and meatus may exhibit any of the characteristic lesions of constitutional syphilis.

In the secondary stage of the disease dry or moist papules are observed. These when they involve the meatus are prone to ulcerate or to form papular overgrowths, accompanied by marked purulent secretion. As a result of free suppuration and blocking of the canal, perforation of the drum and suppurative disease of the middle ear may result. Condylomata are the most frequent specific lesions of the meatus.

Gummata of the external auditory meatus appear in the form of moderate-sized chronic abscesses. These are, however, extremely rare.

The middle ear if involved shows the changes incident to catarrhal inflammation. This is usually secondary to suppurating lesions of the throat.

The pharyngeal opening of the Eustachian tube is frequently the seat of chancre—the infection being carried by the Eustachian catheter—of mucous patches, and of gummata. Cicatricial contraction following these lesions may completely block the Eustachian tube. Syphilitic otitis media may assume the

suppurative or the sclerosing form. Meningitis, sinus thrombosis, facial palsy, and the other complications of non-specific middle-ear disease may develop. Local treatment is of cardinal importance.

The labyrinth is exceptionally attacked in the early secondary stage of the disease; usually this is a late tertiary manifestation, and it is much more frequent in congenital than in acquired syphilis. Tinnitus, vertigo, and sudden onset of deafness are the chief symptoms.

Diagnosis.—This is founded on the history of syphilis and the absence of other discoverable cause for disturbance of hearing. The rapid onset of deafness is also characteristic. The prognosis always should be guarded. The most severe cases sometimes recover promptly as the result of specific treatment; the mildest cases may remain uninfluenced by mercury and the iodides.

Treatment.—This when the meatus is involved should comprise thorough cleansing, the use of astringents, and the application of cauterants to ulcerating spots. Extensive overgrowths and polypi should be detached by snaring or curetting.

When the labyrinth is involved the specific treatment should be pushed to its extreme limit. The prognosis is unfavorable in these cases.

SYPHILIS OF THE RESPIRATORY TRACT

Syphilis of the Nose.—Primary lesions of the nose are extremely rare. A few cases are recorded due to the use of infected instruments, and in some instances the disease has arisen from unnatural practices.

Secondary manifestations, in the form of moist papules, frequently appear about the nostrils.

Gummata involving the external nose exhibit a predilection for the wings, the point, the cartilaginous septum, and the neighborhood of the tear-ducts. These gummata, beginning first in the subcutaneous tissues, extend in depth, involving the bones or cartilages beneath. When there is also gummatous infiltration of the walls of the nasal cavity marked deformity results.

Syphilis of the Nasal Cavities.

1. Syphilitic rhinitis.
   - Acute.
   - Chronic; hypertrophic.
   - atrophic.
2. Gummata.
   - Nodular.
   - Infiltrating.

Acute Syphilitic Rhinitis.—Acute rhinitis, one of the most frequent secondaries of hereditary syphilis, is comparatively rare in the acquired form of the disease. It begins much as does a simple catarrhal rhinitis, and at first cannot be distinguished from this affection; later it develops one of the chief characteristics of syphilis,—polymorphism. If the nasal cavities are examined, the inflammation will be found to vary in intensity even in different parts of the same nostril. Ecchymoses, abrasions, superficial ulcerations, and at times mucous patches may be seen, particularly on the septum and the lower turbinals. The posterior nares are at first but slightly involved; later they show the char-

acteristic thickening, hyperæmia, and dusky redness of acute inflammation; by this time deeper lesions will have developed anteriorly.

Acute specific rhinitis differs from the catarrhal inflammation by persisting in spite of careful treatment and by giving blood-stained discharge or hemorrhage not at the beginning of the attack, but later when erosions and ulcers have developed. Usually the accessory nasal cavities are but slightly involved. Hypertrophic and ultimately atrophic rhinitis may be the direct sequelæ of the acute inflammation.

Hypertrophic rhinitis presents a spongy, swollen, polypoid mucous membrane, so thickened that practically no breathing-space is left. Ulceration is often present, particularly on the nasal septum, the lesion here being sharply defined and exhibiting an unhealthy, readily bleeding surface.

The secretion is abundant, often blood-stained and stinking. The mucous membrane of the maxillary, frontal, and sphenoidal sinuses may become involved, causing, from retained secretions, severe headache or neuralgic pain, and finally abscess. Since the mucous membrane is closely applied to the nasal bones and cartilages, particularly that overlying the lower turbinals, perichondritis, periostitis, ostitis, caries, and necrosis generally complicate chronic specific rhinitis. Bone- or cartilage-involvement commonly gives rise to no subjective symptoms beyond deformity and blood-stained discharge, complete perforation of the septum often taking place without the patient being aware of it. The nostrils may be so effectively closed that mouth-breathing, with its evil consequences, results. The sense of smell may be lost, and the tear-ducts may be chronically inflamed or may be obliterated.

Atrophic rhinitis follows the hypertrophic inflammation, or may be caused by the wasting which follows gummatous infiltration. The turbinals are often involved in the atrophic process, and may be covered by thick offensive crusts concealing ulcerations. The abnormal roominess of the nasal cavities, the thin, bloodless, scar-like mucous membrane, and the fetor are characteristic of atrophic rhinitis, whether it be specific or not.

Diagnosis.—The diagnosis of chronic syphilitic rhinitis must be based on a specific history or associated signs of the disease, since it does not differ from the catarrh observed in non-syphilitics, particularly in those of a strumous diathesis.

Gummata.—These lesions when they are developed in the nasal cavity are usually late tertiaries. If not treated promptly and energetically they produce conspicuous and irremediable deformity of the external nose. They appear as distinct nodules or as diffuse infiltrations.

The *gummatous nodule* attacks by preference the cartilaginous septum and the floor of the nasal canals. Occasionally it is found on or near the alar cartilages. It is usually single, grows slowly, rarely reaching the size of a small cherry, and is often associated with syphilitic rhinitis or gummatous infiltration. Though painless in its course, if untreated it commonly erodes the underlying cartilage or bone. The resulting deformity is much less than that incident to the breaking down of gummatous infiltration. Gummata growing from the mucous membrane covering the alar cartilages perforate the latter and open into the nasal cavity. When they originate in the

cartilage itself the perforation may be external. In the latter case ulceration may extend to the lower border of the cartilage, and be followed by a peculiar pinching deformity, which may be symmetrical.

Gummata on the floor of the nose are rarely detected until they have broken down and formed ulcers, or until they have opened into the mouth. The upper portion of the nasal cavity is rarely attacked by the nodular gumma.

Gummatous infiltration is the affection which causes the most marked nasal deformities. It involves both the mucous membrane and the underlying perios-

FIG. 414.—Gummatous ulceration destroying the nose. (From the collection of photographs of Dr. George Henry Fox.)

teum and perichondrium, and extends rapidly both in depth and in surface. Because of rapid interference with blood-supply, it is prone to slough, the destructive process extending wide of the original infiltrate. Bones and cartilages rapidly necrose; there may be complete destruction of all the cartilages and the bones immediately surrounding the nasal space. Necrosis of the cribriform plate of the ethmoid and the vomer, by taking away the support of the nasal bones, allows them to sink, even though they are not involved, produc-

ing the so-called saddle-back nose. This is more commonly due to associated necrosis of these bones, which may cause complete destruction of the nose (Fig. 414). From extension of the inflammation the ethmoid, the sphenoid, the palatal bone, and the superior maxillaries, particularly the palatal, nasal, and alveolar processes, may become extensively diseased.

Diagnosis.—Gummata and gummatous infiltrations, involving the mucous membrane of the nose, are characterized by ordinary catarrhal symptoms, but differ from catarrh in the fact that the symptoms are constantly referred to the same diseased area. When ulceration becomes deep, involving bones, and before this in hypertrophic and atrophic rhinitis, the discharge is extremely offensive. On examination the destructive process is often found to be widespread. Rounded ulcers, often covered with thick crusts, mark the position where, on probing, dead bone is detected. As a result of gummatous involvement of the cribriform plate, lethal inflammation may extend to the meninges of the brain.

In the early stages, where there is simply beginning infiltration, the symptoms and lesions are so like those of chronic catarrh that differential diagnosis may be impossible. The history of the case, the presence of possibly specific lesions resisting the ordinary catarrhal treatment, and finally the therapeutic test, should decide this question before destruction of bone has taken place.

When perforation of the septum is found the disease is almost certainly syphilitic, though tuberculous lesions may produce the same result.

Syphilitic involvement of the olfactory nerves, commonly due to pachymeningitis of the base, may cause anosmia.

Treatment consists in the internal administration of specifics and in local cleanliness, accomplished by antiseptic and stimulating sprays and vapors. Exceptionally the bone-lesions are premature—*i.e.,* they complicate secondary syphilis; mercury should then be combined with the iodides. When these lesions are distinctly gummatous in type—and under such circumstances they are nearly always late tertiaries—the iodides form the basis of treatment, supplemented by mercury, administered preferably by inunctions. When dead bone is found it should be removed. This is accomplished under ether by means of the finger of the surgeon aided by a curette. Bleeding is often profuse, but is readily controlled by packing. Following this the whole nasal cavity must be cleaned every two hours with sprays, the first containing hydrogen peroxide twenty-five per cent., the second dilute solutions of thymol, or Dobell's solution, or other disinfectants and antiseptics. Insufflations of iodoform and iodol may be serviceable after the cleansing spray. When a small portion of bone is necrotic it is safe to wait until this is loosened before attempting to remove it, at the same time pushing the constitutional treatment.

For the deformity of the nose which sometimes results from cicatricial contraction following extensive necroses, plastic operations of various kinds are indicated. Perhaps the most satisfactory from a cosmetic standpoint is the insertion of an artificial bridge of bone transplant. Over this the loosened skin is drawn by the percutaneous suture. When there is not enough healthy tissue for this procedure, the fitting on of an artificial nose is advisable.

Syphilis of the Larynx.—Secondary lesions of the larynx appear either as a general erythema, not distinguishable from that incident to cold or

irritation, or as mucous patches, which are mostly found on the aryepiglottic folds, the vocal bands, the arytenoid cartilages, and the borders of the epiglottis. These papules are sometimes converted into superficial erosions, but usually yield quickly to constitutional treatment, leaving no trace, save at times alteration of the voice, due to slight thickening of the mucous membrane. Very exceptionally these erosions become true ulcers, closely simulating those incident to gumma, except that they are not so deep nor so destructive.

Tertiary lesions may be expressed in the form of a diffuse gummatous infiltration or circumscribed gumma.

Diffuse gummatous infiltration usually attacks the epiglottis, the vocal cords, and the posterior wall of the larynx. The mucous membrane is reddened and thickened, and there is ill-defined, widespread infiltration of the surrounding tissues. If ulceration takes place it is generally superficial, though a large surface may be involved.

Symptoms.—The symptoms are due to disturbance of function incident to infiltration. There is little or no pain. Until the voice becomes husky the patient's attention is not markedly attracted to the throat. Very slowly progressing ulceration and subsequent cicatricial contraction produce marked alterations in the voice and may obstruct breathing. Exceptionally there is immediate total aphonia, followed later by partial stenosis, with the constitutional symptoms dependent upon dyspnœa.

Diagnosis.—This is founded upon the discovery of a thickened, often superficially ulcerated area, without associated diseases of the lungs, and with a preceding history of syphilis and often other manifestations of the disease.

Tuberculous laryngitis, the only affection with which it is liable to be confounded, is hardly ever encountered in conjunction with healthy lungs.

Circumscribed gummata involve by preference the epiglottis, the aryepiglottic folds, the true and false vocal cords, and the posterior wall of the larynx. At first they appear as rounded elevations, the mucous covering of which is thickened; later softening takes place and deep destructive ulcerations are formed, ultimately resulting in cicatricial contraction, which seriously interferes with the function of the larynx. During the ulcerating stage acute œdema sometimes develops and threatens death from suffocation.

Symptoms.—The symptoms are much the same as those of diffuse gummatous infiltration, except that the discharge is more profuse, pain and tenderness are more frequently noted, and functional disturbances are more marked.

Diagnosis.—This is founded on laryngeal inflammation associated with nodules and ulcers and the existence of a history and other signs of syphilis.

In distinguishing these lesions from those of *tuberculosis* it must be remembered that the mucous membrane surrounding syphilitic ulcers is practically normal in color or congested, not pale. The development of the gummatous infiltration is much more rapid, and the therapeutic test will usually lead to a correct diagnosis.

The syphilitic ulcers develop quickly, sometimes in a few days, and are surrounded by reddened, œdematous mucous membrane. The ulcers are usually single, and involve by preference the upper surface of the epiglottis. Tuberculous lesions require months for development.

The distinction between gummatous and carcinomatous infiltration is de-

pendent on somewhat the same difference in symptoms, though occasionally microscopic examination of an excised piece will be necessary before the true nature of the case can be determined. The differential diagnosis between syphilitic, tuberculous, and cancerous laryngitis may be tabulated as follows:

Syphilis.	*Tubercle.*	*Cancer.*
Development of ulcer acute, occupying only a few days.	Development slow; follows throat symptoms after several months.	Intermediate in time; appearance of ulcers in a few weeks.
Considerable irregular inflammatory or œdematous swelling.	Uniform, pale swelling, looking like an infiltration.	Nodular excrescences and acute inflammation of neighboring mucous membrane.
Epiglottis affected, if at all, on upper surface.	Lower surface.	No uniformity.
Ulcer solitary; rarely more than two.	Ulcers numerous.	Ulcer solitary.
Proceeds from centre to periphery, or from above downward.	The reverse is true.	Irregular in its course.
Deep, round, or oval.	Generally round.	Irregular in shape.
Diameter of one-third to one inch.	Diameter much smaller (one-sixth to one-twelfth inch).	Diameter much smaller.
No cachexia.	Phthisical appearance.	Cachexia.
Treatment usually highly beneficial.	Treatment has but very moderate effect.	Treatment has no effect.

Prognosis.—The prognosis of gummatous laryngitis is good if the diagnosis is made before ulceration has had time to effect much destruction of tissue. Resolution under specific treatment is usually prompt. When ulceration is extensive, medicine cannot prevent cicatricial contraction and interference with function. Under these circumstances, when dyspnœa sets in, dilatation of the strictured portion, often supplemented by internal laryngotomy and the wearing of an intubation tube, or tracheotomy, will be necessary. In addition to constitutional treatment, during the gummatous stage of laryngitis the lesion should be touched daily with iodine, 1 part, potassium iodide, 10 parts, glycerin, 100 parts; it having been previously sprayed and cleaned by antiseptic solution of sublimate 1 to 2000. Following this the lesion should be dusted with iodol.

Syphilis of the Lungs.—The trachea and bronchi exhibit the lesions of secondary syphilis in the form of mucous patches, which in the few observed cases were situated on the posterior walls of these tubes and were credited with causing an obstinate bronchitis, yielding only to specific treatment.

Gummatous ulceration of the trachea and bronchi may be extensive and superficial, or localized and deep. It is commonly placed about the tracheal bifurcation, and may cause necrosis of one or more rings, these in some few cases having been coughed up. As a result of this gummatous ulceration, the surrounding organs are involved, and in some cases the œsophagus, the aorta, and the posterior mediastinum have been opened.

If the respiratory tubes recover from the inflammatory process, subsequent cicatricial contraction may seriously embarrass respiration.

Symptoms.—When the trachea is involved in addition to bronchoscopic findings there may be an obstinate cough, with expectoration of blood-stained sputa, and some pain and tenderness behind the sternum. Large tracheal râles may be heard on auscultation. When the bronchi are invaded the prognosis is less favorable than when the trachea alone is attacked.

Syphilis may attack the lungs in the form of acute catarrhal or croupous pneumonia, somewhat atypical in development, symptomatology, and course, and yielding to constitutional treatment. This is exceptional.

Lung-symptoms depending on syphilis usually develop in the late tertiary period. Two forms of lesions are observed:

1. Diffuse sclerosis, characterized by bronchial catarrh, and alternate areas of dulness and resonance.

2. Circumscribed syphilitic gumma, single or multiple, usually found in the middle third of the lungs, but occurring also at the apices. The patient may exhibit all the symptoms of typical phthisis.

A form of chronic pneumonia characterized by diffuse interstitial infiltration is sometimes found in hereditary syphilis. This may involve the entire lung or only a portion of it, and is a frequent cause of death. The alveolar septa are so thickened by the specific infiltrate that the air-spaces are greatly encroached upon, the lungs cannot expand, and the pulmonary circulation is interfered with.

Gummatous pulmonitis, the so-called syphilitic phthisis, under which head are included the diffuse and circumscribed infiltrations, develops as an ordinary case of consumption, except that the constitutional symptoms are at first less marked and the course is less rapid. The disease begins with a cough, slight dyspnœa, and moderate expectoration, usually without fever. Percussion dulness and bronchial breathing are found over the diseased area. As the gummatous infiltrate increases, the expectoration becomes more profuse and cavities form. Hectic fever is developed, and all the characteristic symptoms of advanced phthisis appear.

The mid-portions of the lungs are, according to the majority of reports, most frequently affected.

Diagnosis.—The diagnosis, usually not made, might be indicated by a positive Wassermann reaction, a syphilitic history, and the presence of other manifestations of the disease, such as laryngeal lesions, perforation of the palate, and skin cicatrices. Tubercle bacilli are not found in the expectoration; this in itself is suggestive of syphilis. A two weeks' treatment by arsenic and inunctions supplemented by iodide internally should produce marked improvement of symptoms if the disease is syphilis. Tuberculous involvement is made worse by such treatment.

Primary involvement of the pleura, with characteristic symptoms of pleurisy, is almost unknown. There may, however, be a pleuritis with effusion secondary to specific pulmonary involvement.

Treatment.—This is practically the same as that applicable to cases of pulmonary tuberculosis, with the addition of arsenic, inunctions of mercury, and potassium iodide kept below the limit of gastro-intestinal upset or manifestations of the toxic action of the drug.

CHAPTER XXXIX

SYPHILIS OF THE BONES AND JOINTS

Lesions of the bones are among the frequent manifestations of constitutional syphilis.

Symptoms of bone-involvement may appear early, at times even before the skin eruptions. Usually the lesions are distinctly tertiary in type and in their time of appearance.

The scrofulous temperament, cachexias which are liable to be attended with alteration of the bones, as gout or rheumatism, and particularly traumatism, often slight and unnoticed in itself, are causes which predispose to the development of specific bone-lesions. Superficially placed bones, such as the frontal bone, clavicle, sternum, radius, ulna, and tibia, are affected most frequently mainly because they are so often exposed to slight injury.

The lesions produced by syphilis vary from a simple periostitis to the formation of typical gummata. These lesions may undergo resolution, or may be followed by exostosis, eburnation, caries, and necrosis. They may be classed under the following heads:

1. Simple osteoperiostitis.
2. Rarefying ostitis.
3. Gummatous osteoperiostitis.

Osteoperiostitis, also called *precocious periostitis,* may develop at the time of skin eruption, or even before this, within three weeks of the appearance of a chancre; commonly it occurs either in the first three months of the disease or in the tertiary period. Pathologically it does not differ from osteoperiostitis due to non-specific causes. The periosteum becomes hyperæmic, and there is cellular infiltration of its deeper layers and the contiguous portion of the bone. The bones of the cranium, the tibia, the ribs, the sternum, and the clavicle are most frequently affected.

Symptoms.—These are subacute in type. On examination there is detected a tender, slightly elastic swelling, evidently growing from the bone; the skin may be slightly puffed and reddened, and the pain is often intense, especially at night. Usually the symptoms yield promptly to treatment, the swelling disappearing without leaving a trace of its seat. Sometimes in place of resolution, osteogenesis takes place, and bony nodules permanently mark the seat of trouble; or from a deposit of bone on the walls of the Haversian canals the osseous tissue may become unduly dense, resulting in eburnation.

Rarefying Ostitis.—When the inflammation is more intense the cellular infiltrate not only invades the lower layer of the periosteum and the bone surface, but penetrates along the course of the Haversian canals, eroding their bony walls, and substituting for the solid osseous substance soft embryonal tissue. If the process is acute the normal tissue may entirely disappear at the seat of infiltration, and suppuration may take place, resulting in the formation of a bone abscess and in caries or necrosis.

Usually the embryonal tissue gradually encroaches upon the bone-tissue, till the latter much resembles sponge in shape and structure, or the infiltrate may become organized, obliterating the lumen of the Haversian canals, and filling the medullary canal with a hard, heavy, compact, osseous tissue, producing eburnation. Caries and necrosis may also occur at the seat of eburnation as a result of ischæmia incident to obliteration of the Haversian canals.

Gummatous Periostitis, Ostitis, and Osteomyelitis.—While the simple and rarefying forms of osteoperiostitis offer no clinical or pathological features which will distinguish them from similar lesions due to causes other than syph-

Fig. 415.—Gummatous osteomyelitis of femur.

ilis, except their tendency toward bone formation, the formation of gummata in bone points definitely to syphilis. The lesions appear as tumors varying in size and exhibiting a tendency towards centric caseous degeneration. These tumors are formed by rarefying ostitis in which the superabundant subperiosteal or medullary embryonal tissue undergoes the changes and arrangement characteristic of the gumma. These gummata may develop in the deeper layer of the periosteum, in the bone-substance, or in the medullary cavity. They are usually multiple, and may invade any portion of the skeleton.

The gummatous involvement of the bone may be circumscribed or diffuse.

Circumscribed gummatous osteomyelitis appears in long bones in the form of nodules developing in the medullary canal. Centrally they are found

to be softened or undergoing caseous degeneration, while peripherally they are surrounded by a sclerosed area. In the spongy tissue the gummata are imperfectly encapsulated by the same fibrous formation (Fig. 415).

Diffuse Gummatous Osteomyelitis.—The lesions of this form of bone syphilis more frequently involve the soft parts in gummatous changes, resulting in the formation of fistulæ leading to the bone. The periosteum is always infiltrated; the bone is greatly deformed and appears worm-eaten. Its surface is irregular, studded with osteophytes, perforated with small or large openings, and exceedingly unequal (Figs. 416 and 417). Some of these per-

FIG. 416.—Skull showing the results of gummatous osteoperiosteitis

forations are small, others as large as two-fifths of an inch in diameter. On section of the bone hyperostosis and eburnation will be found in some regions, and marked rarefaction in others, the whole bone being considerably increased in volume (Fig. 418). The new ossification is exceedingly irregular in position and consistence. The bone is often so brittle that the least effort is enough to break it. Indeed, the irregular eburnation and rarefaction are considered by Ollier as characteristic of the osseous lesions of syphilis.

All these lesions are marked by indolence of inflammatory symptoms and by rarity of extensive necrosis. As a result of intense rarefying periosteitis, particularly where this is diffuse, there is always destruction of bone-tissue. When the flat bones are attacked, lesions may be circular or semicircular

in arrangement. This circinate arrangement is rarely observed in the long bones. Nearly always associated with the destruction of tissue there is noticed peripherally a formative ostitis. This follows the course of destructive action, resulting in overgrowth and eburnation.

Necrosis is usually a feature. Most of the sequestra are found to be eburnated. Sometimes the bone seems almost normal in structure, often being cut off from its nutrition by a peripheral gummatous infiltration, which obliterates its vessels and deprives it of nutrition.

Tegumentary lesions may cause bone necrosis by extension of infiltration to the periosteum; thus the nasal bones and cartilages are most frequently destroyed.

The more chronic forms resulting in osteosclerosis and osteoporosis are

FIG. 417.—Vault of the cranium exhibiting the results of gummatous osteoperiosteitis

attended with few subjective symptoms, perhaps nothing more than boring nocturnal pains, which are usually considered as rheumatic.

Symptoms.—The symptoms of gummatous bone-involvement are, when the lesion is circumscribed and begins in the periosteum, fairly characteristic. There is formed a painless, sometimes excessively painful, tumor of slow growth, which softens centrally and exhibits a peripheral ring of dense induration. Several bones are often invaded at the same time, or the lesion is multiple, and there is commonly a syphilitic history to be elicited. The diagnosis between syphilitic and tuberculous ostitis is based in the main upon X-ray findings, which show always in syphilis marked osteogenesis, little if any in tuberculosis. Tuberculous lesions of the bones of the skull and of the shafts of the long bones are rare; syphilitic involvement is common.

Tuberculosis has a special predilection for the epiphyses of the young.

Osteosyphilosis of the Cranium.—Precocious osteoperiostitis and ostitis, and tertiary exostoses, are frequently observed in the bones of the cranium. The exostoses may develop upon both the external and the internal tables. In the latter case they are of moment from the meningitis which they excite. Rarefying ostitis and gummatous periostitis are often observed, with consecutive eburnation, as are also circumscribed gummata. These lesions may develop in the diploe, or in the pericranium, or in the dura, involving the bone subsequently.

When placed upon the cranium the gummatous lesions exhibit a circinate arrangement and cause but scanty suppuration. Frequently small and multi-

Fig. 418.—Rarefying gummatous osteitis of ulna. (Skiagram by Dr. H. K. Pancoast.)

ple gummata will involve a considerable extent of surface, circumscribing a large portion of the internal or the external table, which eburnates, becomes ischæmic, and necroses. When the pericranium alone is involved, the external table is destroyed. When the syphiloma is located in the dura mater, it is the internal table alone that is involved. When syphilomata of the pericranium and the dura are developed on opposite portions of the same bone, complete perforation may result. This may also follow from a gumma developing in the diploe.

Gummata of the dura mater are accompanied by a circumscribed pachymeningitis, which is sometimes hemorrhagic. Frequently these gummata developing upon the dura are followed by no external signs, though sometimes they may consecutively involve the soft tissues and suppurate. Dry caries resulting in the formation of stellar cicatrices, sometimes in complete perforation, due to gummatous infiltration followed by absorption, is comparatively

rare. Usually the soft parts are involved, and there is the ordinary form of caries or necrosis.

The external exostoses of the cranial bones are similar to those observed in the other parts of the body. Exostoses encroaching upon the brain are interesting from the fact that they sometimes occasion focal symptoms.

These projections are noticed over the frontal, parietal, temporal, and occipital lobes.

Some instances of general hyperostosis due to syphilis have been observed.

The bones of the face, particularly those of the nose (turbinals, cartilaginous, and bony septum, alar cartilages, less often the nasal bones), are favorite seats of gummatous infiltration. The affection may develop primarily in the bone, or may be secondary to ulcerating or tubercular gumma of the soft parts. The superior maxilla frequently exhibits these lesions, particularly the alveolus, the palatal plate, and the nasal process. The disease usually goes on to necrosis.

The vertebræ exhibit the ordinary bone-lesions of syphilis, but are perhaps especially apt to suffer from circumscribed gummata. Caries and necrosis may develop, followed by spinal deformity—syphilitic Pott's disease. As in tuberculous disease of the spine, the cord and its envelopes, the spinal nerves, and the surrounding parts may be affected either by pressure of the infiltrate or by involvement in the inflammatory process.

Osteosyphilosis of the foramina may from the swelling cause pain, analgesia, or paralysis, due to pressure upon the spinal nerves.

The Tibia is more often involved in tertiary syphilis than any other of the long bones. Caries, necrosis, and exostoses are frequently noted.

The Phalanges.—Syphilitic dactylitis appears in the form of a gummatous deposit, which may involve the subcutaneous connective tissue of the fingers and toes, together with the periosteum and bones of these parts. This involvement appears in a superficial and in a deep form.

In the superficial form there is gummatous infiltration of the subcutaneous tissues, which subsequently involves the ligaments surrounding the joints. If the toes are affected they generally exhibit the lesions through their entire length. In the fingers the hardening and enlargement are commonly limited to a single phalanx.

Syphilitic dactylitis is characterized by a slow, painless swelling, most marked on the dorsal aspect of the finger, and rarely extending farther up than the metacarpo-phalangeal articulation. There is some discoloration of the affected area; the region of the joint becomes swollen, and from softening of its ligaments there results preternatural mobility. These enlargements exhibit an ultimate tendency towards softening and ulceration.

This form of the disease develops as a late secondary or distinctly tertiary manifestation.

The deep form appears as a specific osteomyelitis and periostitis. It usually involves an entire carpus or tarsus, though it may be confined to the opposing extremities of two phalanges. The proximal phalanges of the fingers are commonly attacked, often several at one time. When the metacarpal bones are also involved, these are generally of the thumb and the index finger.

This form occurs late in the disease, from five to fifteen years after the appearance of the chancre. It is chiefly limited to the bones and the periosteum,

the integument being seldom involved. Sometimes, however, when the process is rapid and extensive, ulceration, caries, and necrosis result. As the joint becomes involved, the cartilages are eroded and crepitus may be detected. From infiltration of the ligaments and capsule the function of the joint may be seriously interfered with, the latter being sometimes rendered too loose, or, again, from extensive swelling motion being almost entirely prevented. Even when ulceration does not take place there may be shortening or deformity of the bone consequent upon dry caries or interstitial absorption.

Syphilitic dactylitis occurs much more frequently in hereditary than in acquired syphilis. The fingers are less frequently affected than the toes.

SYPHILIS OF THE JOINTS

Arthralgia.—During the secondary period arthralgia is a common and early manifestation of constitutional disease. This sometimes precedes the eruption, and may be unaccompanied by fever. Pain, which is often much worse at night, is the only symptom. There are no discoverable lesions. .

Synovitis may develop at the same time; usually it comes later; it may be either polyarticular or monarticular. It may appear in the form of hydrarthrosis.

Acute polyarticular synovitis is characterized by practically the same pathological changes that are observed in other polyarticular conditions. In one or two weeks, especially if specific treatment is instituted, resolution takes place.

Acute monarticular synovitis exhibits the same symptoms as the polyarticular form of the affection, except that the disease is strictly confined to one joint, usually the knee, is intensified, and is much more liable to become chronic. Moreover, it yields slowly to treatment. This monarticular form of trouble sometimes follows the polyarticular involvement, resolution taking place in all but a single joint. Pathological changes are in this case more pronounced.

Hydrarthrosis, or chronic hypertrophic synovitis, pursues practically the same course as chronic synovitis from other causes. There is thickening. The synovial membrane is tufted, and there is a gummatous infiltration extending even to the articular cartilages and the ligaments. There is a marked effusion into the joint, and ultimately it may be rendered useless, either from limitation of motion or from absolute fixation. When there is extensive involvement of the cartilages and bones, osteophytes may form, resulting in partial or complete bony ankylosis.

Gummatous arthritis, a late manifestation of syphilis, is characterized by the development of gummata, primarily of the ligaments or articular cartilages, and is generally accompanied by the synovial changes encountered in hydrops articuli—*i.e.*, thickening and tufting of the synovial membrane. In certain cases the nodular gummatous infiltration may be distinctly felt in the general swelling involving the joint.

The amount of serous effusion varies greatly. Either resolution may take place or the joint-cavity may open and suppurate. The joints may be secondarily involved from gummatous or ulcerative processes of the overlying parts, or of the bones entering into their formation.

The joints most frequently involved are the sterno-clavicular and the knee; the elbow, the wrist, and the ankle follow next in order of frequency.

Symptoms.—Gummatous synovitis when it develops first in the capsular synovial membrane causes few symptoms aside from an apparently movable, circumscribed tumor. Exceptionally the whole joint becomes quickly swollen, and there are limitation of motion and rapid muscular atrophy. Ultimately there are more or less fixation and permanent deformity. If the bone is involved in the gummatous process the swelling is usually more marked, the articular extremity of the involved bone becoming distinctly thickened; muscular atrophy is extremely rapid. The subjective symptoms are often in their mildness out of proportion to the apparent severity of the lesions. With a greatly swollen and inflamed knee-joint the patient may be able to walk with comparative ease and comfort. If, however, the cartilage has been eroded there may be total disability, and in any event there is likely to be more or less pain, particularly severe at night.

Diagnosis.—The comparative rarity of syphilitic joint affections and their similarity to tuberculous involvement often lead to an incorrect diagnosis and to the needless loss or sacrifice of an articulation. This is particularly true of the knee-joint. Syphilitic synovitis presents no clinical feature in its course by which it can be distinguished from other forms of synovitis. The tuberculin and Wassermann tests should be employed in all doubtful cases. In the acute forms of the affection the absence of heart-lesions and failure of antirheumatic remedies may suggest the true nature of the synovitis.

Chronic syphilitic hydrarthrosis, in the absence of a history or symptoms of syphilis, cannot be distinguished from tuberculous synovitis except by the Wassermann and therapeutic tests. Under the use of mercury and potassium iodide enormous effusions may slowly disappear.

Gummatous arthritis and synovitis can be positively diagnosed only by the evidence offered by other lesions of syphilis, such as ulcerating gummata of the skin. Tuberculous arthritis differs from the gummatous in the fact that it is often, though not necessarily, associated with characteristic tuberculous lesions elsewhere, that it is more prone to ulcerate and open externally, and that it produces more rapid and extensive destruction of the bone.

Prognosis.—The prognosis of syphilitic joint disease is comparatively good when the affection develops early in the course of syphilis and is recognized and promptly treated. Later, atrophic changes, or those due to infection, produce permanent deformity and disability. The synovitis yields readily to specific treatment. Arthritis, even though cartilages and joints are extensively involved and there are contraction and deformity, is also curable by constitutional treatment, reinforced in cases characterized by abscess formation and bone necrosis by sequestrectomy, partial arthrectomy, or other surgical procedure. Even when total arthrectomy is required, provided the nature of the disease has been recognized, the prognosis is better than if the joint disease has been due to causes other than syphilis.

Treatment.—The treatment of syphilitic joints consists in rest secured by fixation and traction, supplemented by passive movements and massage at a later stage, Bier's congestion and helium therapy to stimulate local circulation, and the administration of specific treatment, usually supplemented by the iodides.

CHAPTER XL

SYPHILIS OF THE MUSCLES, CARDIOVASCULAR AND LYMPHATIC SYSTEMS

SYPHILIS OF THE MUSCLES

Acute irritative myositis develops very exceptionally during the first year of secondary syphilis. The symptoms are identical with those of a muscular rheumatism which is slow in onset and somewhat chronic in type.

There is dull pain, aggravated by pressure or motion. Sometimes this is exceedingly severe. The biceps and triceps are most frequently involved. They sometimes exhibit irritative contraction, seriously interfering with the motion of the part, and controlled only by constitutional treatment.

The symptoms yield readily to vigorous constitutional treatment.

Tertiary syphilis may attack the muscles in the form of—

1. Chronic interstitial myositis.
2. Gummatous myositis.

Chronic interstitial myositis begins as a cellular infiltration of the muscular fibres; the infiltrate subsequently becomes organized into connective tissue, resulting in muscular contractures and atrophy.

The pathological changes are marked in the bellies of the muscles; the anal sphincter and the humeral biceps are most frequently involved, though contractions of the sterno-cleido-mastoid, pectoralis major, rectus abdominals, masseter, and many other muscles have been noted.

Symptoms.—There are, in addition to severe pain, slight tenderness, limitation of motion, and diffuse swelling. As the disease progresses the muscle atrophies and shortens.

Diagnosis.—Chronic syphilitic myositis when unaccompanied by other and more characteristic signs of syphilis may imitate toxic myositis from other causes. The syphilitic affection is unattended by constitutional symptoms or joint-involvement. It develops without apparent cause. It is slowly and persistently progressive, and is shortly accompanied by contracture. Moreover, it exhibits marked predilection for certain muscles. The therapeutic test should positively decide the matter.

Gummatous myositis differs from the interstitial infiltration only in the facts that it is circumscribed, forms a distinct tumor, often involves neighboring parts, and exhibits a tendency to degenerate, soften, and discharge.

Gummata of muscle are usually late manifestations of syphilis; in the malignant forms of the disease these may develop in the first year, and under such circumstances are apt to suppurate.

Symptoms.—Usually gummata develop as painless, slowly growing tumors, seated at the point of insertion of the muscle or in its belly, movable with the latter, but fixed when it is strongly contracted; exceptionally, when infiltration is rapid, there may be great pain and tenderness. The tumor rarely

reaches the size of a man's fist. It may simulate malignant disease so closely that the therapeutic test alone will enable a diagnosis to be made. These gummata are absorbed, soften, or become converted into dense fibroid masses. The trapezius, pectoralis major, gluteus, biceps, and lingual muscles are oftenest affected.

Prognosis.—Diffuse interstitial myositis and muscular gummata if treated early yield completely to iodides and mercury; later, when the muscular fibres have atrophied and cicatricial contractions have occurred, constitutional treatment is unavailing, except to prevent further extension of the syphilitic process.

Syphilitic tenosynovitis may appear in the acute, the chronic, or the gummatous form.

Acute Tenosynovitis may develop in the early secondary period, and is characterized by effusion, tenderness, and swelling along the course of the tendon. It subsides quickly under specific treatment. Several tendons may be affected simultaneously, and there may be great pain and tenderness, and an associated syphilitic synovitis with fever. The affection is more common in women than in men.

Chronic Tenosynovitis.—Rarely chronic tenosynovitis develops, characterized by effusion and crepitation along the course of the tendon. It is accompanied by some thickening of the sheath, especially observed about the extensor tendons of the fingers and toes and the biceps tendon.

Chronic syphilitic tenosynovitis is usually painless and yields slowly to constitutional treatment. It presents the same symptoms as the non-specific inflammations of the tendon-sheaths.

Gummatous Tenosynovitis.—Gummata sometimes develop in the sheath of the tendon. These are painless, and are either round or spindle-shaped. Exceptionally the gumma appears in the form of a diffuse infiltration. These gummata subside promptly under specific treatment. They are most frequently found on the tendo Achilles and the biceps tendon. The diagnosis is usually facilitated by the presence of gummata elsewhere, particularly in the muscles. In the absence of these or other signs of syphilis, a trial of specific treatment should be instituted.

Bursitis.—The bursæ may become acutely inflamed, exhibiting the characteristic symptoms of this affection. This is extremely rare.

Much more common, though still rarely encountered, is gummatous bursitis, usually observed in the prepatellar bursa, appearing in the form of a nodular, painless, fluctuating swelling, which is prone to soften and break down.

CARDIOVASCULAR SYSTEM

Heart.—Syphilitic involvement of the heart, common, but often unrecognized, appears clinically as a late tertiary manifestation, according to Jullien, about the tenth year after the chancre, though its lesions are found much earlier. All three layers may be sites of the disease.

Myocarditis.—This, the common form, may appear as a chronic diffuse infiltration of the muscle by small round cells, these becoming transformed into fibrous tissue, so that the myocardium becomes studded with areas of scar tissue, varying greatly in number and extent in different cases, frequently

lying directly under the endocardium or pericardium, or gummata may form, varying in size from that of a pea to that of a pigeon's egg, chiefly in the walls of the ventricles or in the interventricular septum.

Endocarditis.—The syphilitic form of this disease is less regularly found on the valves than is the "rheumatic" variety. When the valves are attacked but one leaflet may suffer, but the deformity in this one is frequently extreme. The lesions appear as thickened plaques, chiefly on the walls of the ventricles, fibrous processes running from them deeply into the underlying muscle.

Pericarditis is the least serious of the syphilitic lesions of the heart. Gummata are rare; the usual lesion is a "milk-spot."

Symptoms.—There is nothing distinctive of syphilis about the symptomatology of these lesions. As a result of syphilitic involvement of the coronary arteries, angina and the myocardial degeneration incident to arterial obstruction are fairly frequent. Since the vascular degeneration represents a terminal phase of the infection, this being true also of peri-, myo-, and endo-carditis, the benefit incident to specific treatment is that of an arrested, and not of a cured, lesion. Given the presence of other lesions of syphilis, the history of infection, or a positive Wassermann test, arsenic, mercury, and the iodides should all be used.

Prognosis.—This, if the diagnosis be made before loss of compensation has occurred, is distinctly good if appropriate treatment be given. Many cases get practically well; a few die of rupture of a cardiac aneurism or of angina; a considerable percentage are permanently crippled by a compensation so delicately balanced that they can stand no strain.

The cardiac muscle and walls of the aorta are the favorite lurking places of the spirochætes in "clinically cured" syphilis.[1]

ARTERIES.—Any one or all of the arterial coats may be attacked. In the larger vessels, as the aorta, the disease occurs chiefly in patches, and, if trauma be excluded, is the common cause of aneurism. In the smaller arteries there is a more general involvement, leading to impaired function, ultimately to local death. The disease does not equally affect all the arteries of the body; often a single artery or group of arteries is involved.

Symptoms due to inadequate blood supply are those of similar lesions from other causes. When the vessels of the brain are attacked headache is usually the first symptom, and is followed, after an interval of weeks or months, by epileptiform attacks, hebetude, somnolence, paralysis with or without loss of consciousness; finally, coma and death. The symptoms of aneurism due to syphilis depend on its location. Very frequently these enlargements are in the brain.

Prognosis.—This is bad, as the disease is usually discovered only after extensive structural changes have been produced.

Treatment is the same as for other tertiary lesions, except that iodides seem to be particularly indicated.

VEINS.—The veins rarely exhibit syphilitic lesions. Mauriac instances a

[1] Warthin: *Amer. Jour. Med. Sciences,* 1916, clii, 508.

single case of phlebitis and thrombosis involving several vessels and occurring in the first few months of constitutional syphilis.

Phlebitis in secondary syphilis is characterized by superficial localization, multiplicity of veins involved, absence of embolism or serious complications, and recovery under specific treatment.

SYPHILIS OF THE LYMPHATIC SYSTEM

While primary and secondary syphilis produce almost invariably marked effects upon the lymphatic nodes, the tertiary form of the disease manifests itself in the lymphatic system with comparative rarity.

The surface nodes are much more rarely involved than are those in the neighborhood of viscera. Of the deep nodes, postmortem examinations have shown that those ordinarily involved are the bronchial, the pulmonary, the mediastinal, the hepatic, and the gastric.

The superficial nodes most frequently affected are those in the epitrochlear, supraclavicular, interclavicular, cervical, inguinal, and axillary regions. Patients of a scrofulous temperament are most subject to these enlargements.

The sclerous and gummatous types are recognized. Both are characterized by primary enlargement incident to hypertrophy and cell proliferation. The tumor formed is at first regular in outline, smooth, freely movable beneath the skin, and indurated.

Enlargement of a single node is rare. Usually a whole group of nodes in one region of the body is involved. The tumors vary from the size of a cherry to that of a man's fist. Usually they are no larger than a hickory-nut. Having reached this stage, the tumors may slowly undergo resolution, taking sometimes months or even years to accomplish this; or exceptionally they may continue to enlarge, becoming soft, adhering to the skin, and ulcerating, discharging thick, yellowish pus containing shreds of necrotic tissue. The small opening at first formed becomes rapidly large, with indurated, ragged edges surrounded by a brownish-red area of congestion.

Exuberant granulations may be formed, resulting in fungoid growths.

Specific treatment and local applications cause rapid healing of these ulcers. There remains a deep, irregular, pigmented scar. Occasionally these ulcerating syphilitic lymphomata become phagedænic.

Diagnosis.—The diagnosis of syphilitic lymphomata can be established only by careful attention to the history of the case.

Syphilitic adenopathy may closely simulate tuberculous adenitis. The latter, however, is usually observed in infants, or at least during early adult life; is accompanied by other evidences of a tuberculous diathesis; attacks by preference the cervical and submaxillary nodes; is more generalized, and forms larger tumors; commonly exhibits suppurative periadenitis with formation of fistulous tracts not distinctly ulcerative in type; does not become phagedænic, and is not improved by specific treatment. Cancerous adenopathy is nearly always secondary. The tumor grows rapidly, becomes adherent to surrounding tissues, ulcerates, bleeds, and progresses in spite of treatment, producing profound cachexia.

Prognosis.—Except in cases where general ulcerating lymphomata become phagedænic, the prognosis is exceedingly good.

Treatment.—Early treatment nearly always occasions prompt resolution. Both potassium iodide and mercury should be given, the former drug in full doses, the latter internally, and locally in the form of inunctions. Even when distinct fluctuation is noted, the knife may not be necessary.

Local counter-irritation and the administration of tonic and supporting treatment will hasten resolution.

Ulcerating gummata of the lymphatic nodes are exceedingly rare.

The treatment is that of other tertiary lesions.

Syphilis of the Spleen.—The spleen, closely associated as it is with the lymphatic system of the body, is frequently affected in secondary syphilis. There is a distinct enlargement, usually occurring early, but sometimes not for several months. This enlargement is not followed by functional troubles. There is nothing to call the patient's attention to the swelling, and it is rarely observed unless careful search is made for it. It commonly subsides in the course of a few weeks or months. The pathology is probably the same as that of lymphatic node enlargement of secondary syphilis.

Tertiary syphilis may produce gummata or disseminated or localized splenitis, resulting ultimately in partial cirrhosis. These lesions rarely betray themselves in life by appreciable symptoms. It is only as the result of post-mortem examination that their existence has been proved.

They may be suspected when physical examination shows increase in the volume and consistence of the spleen and when deep pressure elicits tenderness. They are nearly always associated with similar lesions of the liver and kidneys, the symptoms of which completely mask splenitis.

CHAPTER XLI

SYPHILIS OF THE URO-GENITAL SYSTEM AND MAMMARY GLAND. PROGNOSIS OF SYPHILIS

SYPHILIS OF THE URO-GENITAL SYSTEM

The Kidneys.—The kidneys are less frequently involved in the lesions of syphilis than are the genitals, the nervous system, or the liver. They may be attacked at any time during the course of the constitutional disease, the lesions produced, with the exception of gummata, being similar to those which characterize Bright's disease in all its varieties.

As etiological factors, tuberculosis, rheumatism, gout, and alcoholism are all of some importance, but the direct exciting cause is either the syphilitic virus or the irritating toxins produced by it in the body and excreted through the kidney epithelium.

Precocious involvement of the kidney often closely follows the chancre, and is manifested by albuminuria, usually intermittent, transitory, and moderate. The total quantity of urine passed daily is not diminished, nor is the specific gravity markedly affected. Microscopic examination at most may show a few hyaline casts. This albuminuria develops during the early eruptive period and subsides promptly under treatment.

Acute syphilitic parenchymatous nephritis is characterized by lesions of the secreting portion of the organ, producing a condition analogous to that termed large white kidney. It is in reality a parenchymatous nephritis, and differs in no way from this acute or subacute form of Bright's disease, presenting the same complications and sometimes terminating fatally.

Albuminuria, granular, epithelial and blood casts, lessened secretion of urine, headache, œdema, and other symptoms and signs of acute nephritis, are present.

The diagnosis is founded on examination of the urine, the acute rapid course of the affection, the associated symptoms and signs of syphilis, and the serologic and therapeutic tests.

The prognosis is favorable. If parenchymatous nephritis develops in late syphilis and is associated with gummatous infiltration or amyloid degeneration of other viscera, the chances of cure are slight.

The more profound kidney degenerations characteristic of tertiary syphilis, but sometimes occurring in the late secondary period, are syphilitic interstitial nephritis and gummatous nephritis.

Syphilitic interstitial nephritis presents the same pathology and lesions as the non-specific form of the disease. The symptoms are those of chronic Bright's disease. This affection is more grave than the early nephropathy. Indeed, after fibrous tissue has once fairly developed, complete restoration of the kidney to its normal condition is impossible.

There is first a cellular infiltration of the interstitial stroma and of the walls of the vessels and perivascular spaces. This infiltration is followed by sclerosis, causing atrophy and distortion of the kidney, particularly noticeable in the cortex.

The symptoms of specific interstitial nephritis are the same as those of the non-syphilitic affection. There are polyuria, lowered specific gravity, light straw color of the urine, moderate amount of albumen, hyaline and granular casts, increased arterial tension, œdema, headache, asthma—indeed, all the well-known symptoms of chronic nephritis.

The diagnosis as to the specific nature of the affection can be made only by finding other signs or symptoms of syphilis.

The prognosis is unfavorable.

Gummatous nephritis is rare. The individual tumors rarely reach large size. Cornil states that they are usually multiple and are found chiefly in the cortical substance or in the pyramids. Interstitial nephritis is nearly always found in conjunction with them.

Jaccoud states that amyloid degeneration is by far the most common manifestation of renal syphilis. Next in order of frequency comes granular atrophy; third, gumma.

Wagner describes a fourth form, which he calls syphilitic glomerulo-nephritis. It is characterized chiefly by hæmaturia and ends rapidly in uræmia.

The treatment of the tertiary kidney-lesions is conducted on the same general principles as would apply to cases of chronic Bright's disease. Arsenic and mercury must be administered cautiously, since on account of the crippled condition of the kidneys they are extremely liable to produce toxic symptoms. Potassium iodide if tolerated is indicated in full doses.

Amyloid degeneration of the kidney is associated with one or more of the forms of syphilitic nephritis. Similar degenerations of other organs, notably the liver and the spleen, are present, and occasion profound cachexia. There are no characteristic symptoms. The prognosis is bad.

The Ureters and the Bladder.—Syphilitic involvement of the ureters so far as symptoms are concerned is practically unknown. For description of syphilis of the bladder, see p. 500.

The Epididymis and Testis

The syphilitic virus may manifest its influence upon these organs either in the form of interstitial inflammation characterized by infiltration, formation of connective tissue, and atrophy, or in that of gummata.

As clinically observed, syphilitic lesion of the testicle appears as a combination of the forms just mentioned. Both epididymis and testis may be involved, the sclerous and gummatous processes going hand in hand. There is often an accompanying hydrocele. The lesions may be observed at almost any period of syphilis from the second month to the twentieth year.

Syphilitic Epididymitis.—The epididymis when involved commonly presents an indolent, non-inflammatory, indurated, sharply circumscribed gumma, usually of the right globus major. Both epididymes may be affected simultaneously.

Involvement of the epididymis without implication of the testis is rare. It usually develops towards the end of the secondary period of the disease. It may be observed at any time during the secondary eruptions, and at this period undergoes prompt resolution on treatment, since, like all the secondary lesions, it has no marked tendency towards sclerosis or caseous degeneration.

When it develops in the late tertiary period it corresponds more closely to the type of the tertiary lesions—that is, it tends to break down and ulcerate. This occurrence is much rarer, however, than is the case with tuberculous lesions.

The enlargement never attains great size. There are rarely more than two nodules, which after some months become of almost cartilaginous hardness. Exceptionally there may be a number of small nodules, grouped at either extremity of the epididymis, the middle portion being spared.

Sometimes this affection may be acute in its onset and accompanied by inflammatory symptoms. On examination, however, a rounded tumor at the head of the epididymis, or at both the head and the tail, with slightly irregular surface, not adherent to the surrounding tissues, probably circumscribed, and without fusion into the tunica vaginalis, suggests the nature of the lesion.

Diagnosis.—The diagnosis of syphiloma of the epididymis is readily made. The absence of pain, of tenderness, of involvement of the skin, and of hydrocele, together with the infiltration of the head of the epididymis rather than of the tail, would exclude gonorrhœal epididymitis.

From tuberculous epididymitis a differential diagnosis based upon the local symptoms alone may be difficult. The tuberculous infiltrate usually involves the caput major, producing a hard, painless induration much like that characteristic of syphilis. This steadily grows larger, presents a more irregular and nodulated surface than does the syphiloma, becomes adherent to the skin of the scrotum, softens, and discharges, forming fistulæ. Tubercle bacilli can be demonstrated in the discharge by inoculation. The cord becomes indurated, and the seminal vesicles and prostate are usually involved.

Treatment.—Arsenic and mercury are indicated.

Syphilitic Orchitis.—After the heart, larger blood-vessels, and central nervous system, the testicle is the most frequent seat of tertiary syphilis. This organ may be involved in the early months of the secondary period; usually the third year is the time during which tertiary symptoms develop.

The affection may assume the sclerous or gummatous form, though it must always be recognized that these two processes run their courses side by side, and that, while the predominant lesion may appear as a cellular infiltration of the albuginea and its trabeculæ followed by cicatricial contraction, an examination of the diseased testicle shows the presence of small or large gummata. *Per contra,* even though the affection appears to be entirely gummatous, it is always associated with a greater or less degree of interstitial orchitis. Whether the lesion conforms to the sclerous or the gummatous type, its onset is insidious, and it is often bilateral. Its course is exceedingly chronic, and it terminates in (1) resolution, (2) partial or complete atrophy, or (3) destruction by ulceration.

There is reason for believing that an important predisposing cause of syph-

ilitic sarcocele is gonorrhœal epididymitis; traumatism or sexual excesses may also lessen local resistance.

Interstitial or sclerous orchitis is the common form of syphilitic sarcocele. It may be unilateral or bilateral. It is usually symptomless, but if progressive may be accompanied by a sense of weight and enlargement.

The testis enlarges uniformly to two or three times its normal bulk. It forms an indurated, non-sensitive tumor. The epididymis is flattened along its posterior border, so that it becomes difficult to recognize it on palpation. The cord is rarely involved. The surface of the tumor is usually smooth, though it may be nodular or ridged. Testicular sensation on pressure is lost.

The tumor forms slowly, requiring weeks or months for its complete evolution. It may remain stationary for months, and finally subside, leaving an apparently normal testicle, or, in place of resolution, there may be sclerogenesis and complete atrophy, the testicle disappearing and the vas terminating in a fibrous nodule.

It is to be noted that even though both testicles are involved there is not necessarily either impotence or sterility, since the infiltration generally spares some of the interstitial portion of the gland.

Acute Syphilitic Orchitis.—Exceptionally this sclerous orchitis may depart from its ordinary type and the symptoms may become so acute as entirely to obscure the diagnosis. In this form of the disease the testicle rapidly swells, and becomes exceedingly sensitive; the scrotum is reddened and œdematous, and there is violent and constant pain.

Commonly but one testicle is affected. Acute symptoms last but a few days. The inflammation comes on without exciting cause, rarely presents symptoms as acute as those of an inflammatory orchitis, and is distinguished from gonorrhœal epididymitis by the fact that the testicle is primarily enlarged and presents the same form and density as are observed in the ordinary syphilitic sarcocele.

As a rule, the tunica vaginals is not affected in syphilitic sarcocele, or there is but moderate serous effusion. This is sometimes circumscribed, and may assume a pseudo-membranous form. Exceptionally the effusion is so great as to prevent palpation of the testicle.

Gummatous Orchitis.—The development of gummata is often preceded by the sclerous type of syphilis of the testicle, though frequently the affection is distinctly gummatous from its onset. In place of the general enlargement, or rather accompanying this, distinct nodules, ridges, or tumors appear, usually on the anterior surface of the testicle. These tumors increase in size. The tunica vaginalis becomes adherent; the overlying skin of the scrotum is infiltrated and reddened, and finally softening and ulceration take place, with evacuation of broken-down granulation-tissue and gummy pus. The resulting punched-out hollow ulcer has dusky indurated borders, and communicates with a ragged, irregular cavity containing gray unhealthy granulations. The scar left after healing is adherent to the testicle.

At times the granulation-tissue slightly proliferates, and forms a cauliflower growth projecting externally and overlapping the seat of skin perforation; this is known as a benign syphilitic fungus.

There are two varieties of syphilitic fungus—the superficial and the deep. Both originate from ulcerating gummata. The superficial fungus starts from gumma of the scrotal tissues or of the tunica albuginea. A superficial form which is almost identical and is more common is due to tubercle.

Parenchymatous or deep fungus is usually syphilitic. It arises from gumma of the testicle proper. The granulations grow upward through the albuginea and the tissues of the scrotum. At times portions of the seminiferous tubules will be found in the discharge.

Softening and ulceration do not always take place. As in the case of interstitial orchitis, gumma may spontaneously, or from the effect of treatment, undergo resolution, leaving the testicle apparently as healthy as before the attack, or crippled and deformed by cicatricial contraction.

According to Warthin, "the testes of all old syphilitics show a more or less marked degree of orchitis syphilitica fibrosa. This is patchy in the early cases, but tends to become diffuse and may involve the entire organ. The germinal cells are vacuolated in the early stages, and there is a gradual loss of spermatogenesis, with a hyaline thickening of the basement membrane of the tubules. In the early stages spirochætæ are found in the basement membrane, and there are slight localized areas of plasma-cell infiltration. In the later fibroid stages spirochætæ are not present." (Author's abstract of paper read at meeting of American Medical Association, 1916.)

Diagnosis.—The diagnosis of syphilitic sarcocele in its typical form is not difficult. This affection commonly develops when other unmistakable manifestations of syphilis are present. The tubercle bacillus and the gonococcus when they invade the testicle attack the epididymis primarily; tubercle commonly invades the cord, the seminal vesicles, and the prostate. Syphilis, however, hardly ever attacks the cord.

Finally, the effect of constitutional treatment and the Wassermann test will be found valuable in clearing the diagnosis.

Lymphadenoma sometimes almost exactly simulates syphilitic sarcocele. It may involve one or both testicles. It usually spares the epididymis. It forms an ovoid, hard, indolent, uniform swelling. It is, however, not so hard as syphilitic sarcocele. Its surface is always smooth, and does not present the slight nodulations or ridges which are often present in the syphilitic testicle. Lymphadenoma may be found in other parts of the body.

Enchondromatous growths may present areas of unusual hardness; the growth is often much more rapid and usually attains much larger dimensions than in syphilitic sarcocele. Local and reflex pains are more pronounced, and specific treatment is without avail. However, it is often necessary to wait before diagnosis can be established.

In the acute form of syphilitic sarcocele diagnosis must be made by exclusion; that is, when the possibility of traumatism, of gonorrhœal inflammation, of gout, of mumps, of tuberculosis, of continued fevers, of violent muscular effort, has been excluded, and other signs of syphilis are present, the syphilitic nature of the affection may be suspected.

Syphilitic fungus of the testicle may be confounded with ulcerating carcinoma or tuberculous fungus. The ulcerating carcinoma, however, involves

the epididymis and cord, affects the pelvic and post-peritoneal lymphatic glands, forms a large indolent tumor, gives rise to much pain, is attended with bleeding and sloughing, and freely secretes ichorous pus. It runs a rapid course, and is attended with cachexia.

The tuberculous fungus differs from the syphilitic only in the fact that the granulations are paler, of less vitality, and not attended with infiltration of the skin. There is usually cachexia.

Prognosis.—The prognosis of syphilis of the testicle is good. There is rarely deterioration of the general health, or abolition of the sexual powers. Although the disease is bilateral, it very rarely produces complete atrophy or destruction.

Even after loss of virility and fecundity, proper treatment will sometimes restore both.

Treatment.—Mercury, arsenic, and the iodides are indicated.

Syphilis of the Vasa Deferentia, Seminal Vesicles, Prostate, Urethra, and Erectile Bodies of the Penis.—There have been reported a few cases of gumma of the vas, usually in connection with syphilitic sarcocele. This structure, together with the seminal vesicles and the prostate, seems to be singularly free from the manifestations of tertiary syphilis; at least, clinical evidence of the frequent involvement of these structures is wanting.

Chancre of the urethra has been already described (see p. 181).

Secondary syphilides, particularly the mucous patch, have been observed on the urethral surface. These occasion a slight discharge, which is sometimes mistaken for gonorrhœa (see p. 181).

Gummatous ulceration is exceedingly rare, or at least is not often recognized clinically. Its symptoms are usually confounded with those of chronic urethritis from other causes. It would be difficult to make the diagnosis except from urethroscopic examination, unless induration could be detected by external examination. It is followed by dense stricture formation.

The primary and secondary lesions of the penis have been already described (see p. 692 *et seq.*).

The erectile bodies of the penis may exhibit tertiary manifestations in the form of diffuse infiltration or of gummata.

Diffuse infiltration particularly involves the meatus and the frænum, together with the mucous membrane of the prepuce lying to either side of this band. Infiltration may be either superficial or deep, and may involve a considerable portion of the glans. Ulceration sometimes follows.

Gummata are usually placed on the proximal third of the cavernous bodies. They form small or large, ovoid, indolent, non-inflammatory, cartilaginous tumors, suggesting during their early development the presence of a foreign body in the tissues.

Gummata and infiltrations markedly interfere with erection, making it imperfect anterior to the seat of lesion and causing bending of the organ. They are obstinate to treatment, and are scarcely to be distinguished from the plates of induration resulting from non-specific cavernitis or fibroid infiltrations.

Diagnosis.—One or more hard, painless, slowly progressive nodules, growing in or from the erectile tissues of the penis, showing no tendency to ul-

cerate, and giving rise to no symptoms other than interference with erection, would be almost pathognomonic of either syphilis or non-specific indurated plaques. Between these two affections the therapeutic test affords the only means of distinguishing.

The tertiary manifestations, which closely simulate various forms of chancre, are much more chronic in their course than the primary lesion, occasion no adenopathy, and begin as infiltrations, which subsequently ulcerate. Moreover, there is a preceding history of secondary syphilis, or possibly the evidence of pre-existing lesions of the disease.

Treatment.—As for all tertiaries.

Syphilis of the Ovaries, Uterus, Vagina, and Vulva

From analogy it might be expected that syphilitic involvement of the ovary would be frequent. Clinical records, however, have very little to advance in proof of this theory. It is probable that a sclerous and a gummatous type of ovaritis occasionally appear as manifestations of tertiary syphilis. This, however, as in the male, occasions no subjective symptoms, follows the law of tertiary visceral lesions in not tending to ulcerate, and hence escapes notice. Autopsies have shown that such lesions occur, and a few clinical observations prove, at least so far as the therapeutic test is concerned, that some ovarian tumors are of syphilitic origin. The evidence is strongly in favor of the view that the ovaries are far less subject to tertiary disease than are the testicles.

The Fallopian tubes are involved in gummatous lesions even more rarely than are the vasa deferentia.

The uterus of syphilitic women is frequently attacked by endometritis, metritis, perimetritis, and parametritis. The symptoms and complications are the same as the homologous non-specific inflammations, and often the treatment is as tedious and unsatisfactory. There are some reported cases of uterine tumor disappearing rapidly under the use of potassium iodide.

The vagina is very exceptionally the seat of chancre. Secondary lesions, except the mucous patch, are also rare. Tertiary lesions of the vagina, usually appearing in the form of a diffuse infiltration, commonly extend from the vulva or the rectum, in the latter case causing recto-vaginal fistulæ. Exceptionally the infiltrate attacks the vagina alone. The symptoms are those of chronic vaginitis, with marked thickening, particularly of the posterior wall, often followed by ulceration and extensive tissue-destruction.

The vulva is a favorite seat of syphilitic lesions in all stages of the disease. The chancre, secondary syphilides, gummata, and gummatous infiltration are all frequently observed. The tertiary lesions are prone to develop in the seats of primary and secondary ulcerations. They are usually multiple, bilateral, quickly ulcerate and spread, and produce a thickening and warty growth of the skin, which strongly suggests elephantiasis. In the debilitated and uncleanly phagedæna develops, with extensive tissue-destruction, and, in case of healing, great cicatricial deformity.

Syphilis of the Mammary Gland

Chancre of the nipple is elsewhere described (see p. 707).

Secondary Lesions.—Upon the overlying and overlapping skin papules are particularly liable to be converted into mucous patches or into condylomata.

Acute irritative mastitis is exceptionally observed in both men and women in the earliest period of secondary syphilis. It is characterized by swelling accompanied by moderate pain and tenderness; it subsides quickly, particularly under specific treatment.

Gummatous mastitis may be diffuse or nodular.

Diffuse gummatous mastitis is characterized by a rather dense infiltration involving a part or the whole of the breast. Both breasts may be attacked together or consecutively. More commonly one side is involved. If untreated, atrophy and contractions take place, ultimately leaving the breast wasted and greatly deformed.

The diagnosis from cancerous infiltration may be extremely difficult, but will be founded upon the more diffuse form of the syphilitic infiltration, the absence of lymphatic involvement, the preceding history of syphilis, and chiefly on the rapidity with which symptoms yield to constitutional treatment.

Gummatous nodules of the breast develop slowly, occasion little or no pain, and are prone to ulcerate and discharge. There is found in or on the breast a hard, painless, non-sensitive, freely moving nodule, which in a few weeks has reached the size of an egg, softened, become adherent to the skin, ulcerated, and discharged a turbid, gummy fluid.

As in the case of diffuse infiltration, these gummata may lead to errors in diagnosis. Gummata do not retract the nipple, they commonly develop before the age of cancer, and they ulcerate in a different way from typical malignant growths. Usually the lymphatic nodes are not involved, and a history or signs of syphilis are obtainable.

Specific treatment ordinarily accomplishes prompt resolution of tertiary manifestations in the breast, and is the main test upon which a differential diagnosis must be founded.

The Prognosis of Syphilis

Syphilis is a clinically and serologically curable disease. This cure is accomplished at times in the absence of all treatment, as suggested by the countless cases of, for instance, locomotor ataxia, without history of primary or secondary lesions, the fair inference being that there are others who exhibit no symptoms through life; as further suggested by the many serologically positive cases who clinically present a clean health record.

In such cases the infection is either destroyed or so inhibited that it becomes a pathological factor of negligible importance.

If treated actively in its primary stage, syphilis is probably cured in the majority of cases, though absolute proof of this is wanting. The same, though to a less extent, is true of the secondary stage. The manifestations of syphilis evidencing an infection of many years' standing, excepting those of the cerebrospinal system and the larger blood-vessels, may usually be cured, but the

infection probably remains, nor is a negative Wassermann a proof of its absence.

Syphilis predisposes to all other infections and to cancer. A persistent infection even in the absence of recognized clinical manifestations impairs health and shortens life, probably by its deteriorating influence on the cardio-vascular system.

As to the prognosis concerning marriage, a man well treated from the first and with a persistent negative Wassermann may marry in two years. The same is true of a woman. A man well treated with a continued positive Wassermann, but no clinical symptoms, may marry after four years. A woman with a continued positive Wassermann should not marry (see also p. 827).

The congenital syphilitic is usually vulnerable and short-lived. If his diagnosis be formulated on the Wassermann reaction alone, and general health be maintained in infancy, he may develop tertiaries later on, but probably will not do so.

CHAPTER XLII

HEREDITARY SYPHILIS

Syphilis is transmitted as an active, contagious disease. It reaches the child from the mother, who is always infected. Simultaneous impregnation and infection of the mother are incident to the circumstance that the spirochæte habitually infects the testicle, and that the infection persists, in the absence of efficient treatment, probably for life. The spirochæte, at least in the recognized form, is not carried by the spermatozoön, for obvious mechanical reasons.

The maternal disease may be due (1) to infection previous to conception, or (2) to infection occurring at this time, or (3) to postconceptional infection.

Descent from a recently syphilized mother is more disastrous in its effects than from one in the late stages of the disease, since in its acute course the vitality is more seriously affected and the transmitted infection is at its maximum, both quantitatively and in virulence.

Moreover, there is pronounced placental involvement, profoundly altering the nutrition of the infant. If these inflammatory and vessel-occluding processes are generally diffused over the placenta, the fœtus, of course, perishes. If localized, the fœtus may live for a varying length of time, but will exhibit signs of malnutrition.

Maternal heredity, most potent in the first year of syphilis, gradually becomes attenuated.

Approximately two-thirds of the cases in which syphilis is acquired by the mother at or near the time of conception perish *in utero* or shortly after birth. The obvious effects upon the fœtus are less marked in proportion to the lateness of the infection in regard to conception.

Post-conceptional syphilis—that is, infection of the mother during the period of utero-gestation—may be transmitted to the fœtus up to the eighth month. After that it is probable that the child will escape, although cases are reported showing that chancre acquired in a woman as late as the eighth month has been followed by syphilis of the child.

Direct infection implies inoculation of the child during parturition by the contagious discharges of secondary vaginal or vulvar lesions of the mother. There seems to be no reason why such infection should not exceptionally take place from a chancre acquired too late to affect the child *in utero*.

Syphilis thus conveyed would be acquired, not inherited, and would begin with the primary sore. Infection from secondaries is not probable, since, if the disease has reached this stage in the mother, the child is already syphilized, though clinical signs may be absent.

The Period of Syphilitic Heredity.—It is universally conceded that hereditary syphilis becomes milder in type and less likely to be transmitted in proportion to the age of the disease of the parents. Heredity is most potent and virulent in its first year. There is a rapid attenuation in the third

year, after which the influence of the disease as expressed by transmission still diminishes, but at a slower rate. In the large majority of cases there comes a time when syphilis is no longer transmitted. This rule, however, is subject to exceptions. Transmission years after the original outbreak, and in the absence of all signs or symptoms of the disease in the parents, is possible, and is more common than is generally supposed. Fournier states that of five hundred and sixty-two cases of hereditary syphilis, in sixty, as shown by clinical signs, the disease was transmitted more than six years after the primary infection. Cases are recorded pointing to heredity from parents in the fifteenth and even in the twentieth year of syphilis. The Wassermann test shows late transmission in the latent form to be common.

Treatment exercises upon the heredity of syphilis a more powerful effect than time alone; an active specific treatment of the mother reduces the birth mortality to almost the vanishing point.

The type of parental syphilis does not necessarily indicate that of the inherited disease. Heredity in its most malignant form may destroy the offspring of parents suffering from mild syphilis, and, conversely, virulent outbreaks in the parents may not interfere with the birth of children either but slightly affected or apparently healthy; hence it is unsafe to base prediction as to the type of inheritance upon the type of disease of the parents.

Conceptional syphilis is that acquired by the healthy mother at the time of conception. There is no primary sore, and constitutional symptoms may be entirely wanting.

Colles's law states that a child begotten by a syphilitic father and born of an apparently healthy mother cannot infect her, even though it exhibit venereal ulcers on the lips and tongue and in suckling cause cracks and fissures in the mother's nipple. This is because such a mother is already syphilitic, even though she show no clinical symptoms.

Conceptional syphilis may appear in one of two forms:

1. The woman may shortly after conception become languid, weak, and emaciated, complaining of headaches, rheumatic pains, sleeplessness, and all the symptoms of neurasthenia. Miscarriage occurs, and from this she rallies very slowly. Subsequent pregnancies take much the same course, the miscarriages coming later in the period of gestation. Then living but syphilitic, and finally healthy children, are born.

In many cases undoubted tertiary symptoms appear, such as gumma or periostitis. All these symptoms are usually rapidly cured by specific treatment.

2. The woman may remain apparently well, being delivered at about full term of a child which either at birth or shortly after exhibits the characteristic lesions of hereditary syphilis. Experimental inoculation of such a mother with active virus will not produce chancre. She is immune against syphilis, because she has the disease in a latent form.

Syphilis and Marriage.—The prevalence of acquired syphilis, the frequency with which it is transmitted, in unrecognized form, particularly in regard to the central nervous system, the severity of its lesions, and its crippling, deforming, and often fatal effects when it is inherited, make questions

pertaining to the marriage of syphilitics of cardinal importance. Opinions upon this subject should be clear and decided.

From what already has been said it is obvious:

1. That syphilis is most apt to be inherited from parents who at the time of conception are in their first year of the disease.

2. That the tendency towards obvious heredity becomes less from the first to the third year, and after the fourth year is rarely manifested.

3. That time in conjunction with vigorous continued specific treatment so affects the tendency to heredity that after the fourth year it is usually brought to the vanishing-point.

4. That time and vigorous treatment combined cannot always prevent the transmission of syphilis by heredity. The instances in which such transmission has occurred after four years, in spite of active treatment, are, however, so few that they properly can be rejected in considering syphilis and marriage.

The logical deduction from the foregoing summary is that men who have syphilis which has been treated carefully for two to four years can marry and will have healthy children. When a woman is syphilitic it would be safer to avoid conception till at least two years of negative Wassermanns taken before and after provocative injections of small doses of neosalvarsan prove the complete latency and suggest the absolute cure of the infection. Even then such a woman should be given a carefully regulated specific treatment during pregnancy (see p. 890).

Prognosis of Syphilitic Heredity.—When conception takes place during the early secondary period of syphilis the usual result is abortion, occurring from the first to the fifth or sixth month, the fœtus sometimes exhibiting the evidences of syphilis in the shape of large bullæ upon the palms and soles, or other characteristic lesions, but quite often showing nothing distinctive. Later, when the virulence of the disease of the parents is lessened by time, either abortion occurs when pregnancy is more advanced, or live children are brought into the world which at birth or afterwards show signs of syphilis. One-fourth of these die within the first six months. If they survive that period the chances for life are slightly in their favor, but the chances for health or freedom from disease are overwhelmingly against them.

Veeder [1] reports work done in a very careful manner, as follows:

In 100 syphilitic families 331 pregnancies occurred, which resulted as follows:

Abortions	100 or 30.2 per cent.
Still-births	31 or 9.3 per cent.
Living-births	200 or 60.5 per cent.

This, he states, is a prenatal mortality of 40 per cent., against a normal mortality in the same social strata of 10 per cent.

"Considering next the 200 living births: At the time the data were collected 39 were dead and 161 alive, but 12 of the 161 died during the course of the investigation. Of the 161 examined, 107 had both clinical signs of syphilis and a positive Wassermann; 5 were clinically positive but gave nega-

[1] *American Journal of Medical Sciences,* clii, 1916, p. 522.

tive tests (in all of these the family gave a history of syphilis); 16, although negative as regards clinical manifestations, gave positive reactions . . . Thus but 33 of the 161 living children were free from infection, and if we attribute the deaths occurring before term to syphilis we find that of the 331 pregnancies in 100 syphilitic familes but 10 per cent. escaped the infection."

When the question of prognosis is considered in regard to individual cases, it is safe to predict healthy children from parents who at the time of conception are past the fourth year of syphilis and have been persistently treated. Even after two years in the very great majority of cases the same outlook is justifiable. In the first year prognosis in this respect must be more guarded; but, provided the mother is actively treated during the whole period of utero-gestation, the child will probably be born healthy. Exceptionally families show an inveterate tendency to heredity little influenced by time and treatment. Fournier quotes a case of nineteen pregnancies each resulting in still-birth. In speaking of the prophylaxis of hereditary syphilis, he earnestly advises that a man who has been infected with the disease should be forbidden marriage till time and treatment have accomplished their depurative work, and should be shown without mitigation and without exaggeration the evils which may result from sexual intercourse. He should be told that he may infect his wife directly by sexual contact, or indirectly through the medium of the fœtus, and that, if she fails to abort, she may deliver at term a wizened, deformed, blotchy child, which if it lives may show the stunted development and mental incapacity so characteristic of hereditary syphilis.

When, in spite of warnings, it is probable that sexual life is continued, the man should be subjected to the most rapid and efficient treatment applicable. When conception has taken place from a syphilitic father, the mother should receive active specific treatment during the whole period of utero-gestation.

HEREDITARY SYPHILIS

Hereditary syphilis differs from the acquired disease in being constitutional from the first. There is no primary stage—that is, there is no chancre—nor in the course of its development can the manifestations of the disease be classed under periods. They may correspond in type to secondary or tertiary lesions, but a chronological order such as is observed in acquired syphilis is wanting. For the first two years after birth secondary and tertiary manifestations appear side by side. Later, at about the time of puberty, for instance, if lesions appear, they belong exclusively to the tertiary type.

The local expressions of hereditary syphilis correspond closely with those already described as characteristic of the acquired disease. Thus, the syphilides are pathologically and clinically the same, and this is true of visceral involvements. The main point of difference lies in the profound alteration which syphilis in its hereditary form impresses on general nutrition and development.

In a certain proportion of cases the characteristic symptoms of hereditary syphilis develop at birth or within a few days of this time. Often the child remains apparently healthy for a period of from three to five weeks, manifestations of syphilis then appearing. It seems well substantiated that a child may show no symptoms of syphilis for several years, after which time typical ter-

tiary lesions may develop. In many of these cases it is probable that the post-natal lesions were so few and slight that they were not observed. The form of the disease developing more than three years after birth Fournier called late hereditary syphilis.

The typically syphilitic child is at birth a wasted, wizened, snuffling, feeble creature, with a weak, hoarse cry, often exhibiting a bullous eruption of the skin. It has been blasted *ab initio,* presenting the appearance of an advanced stage of marasmus. The skin is harsh, non-elastic, and gray or dirty yellow in color; its appendages—the eyelashes, eyebrows, hair, and nails—also show imperfect or perverted development. The muscles are wasted. The general condition is well expressed by the term *atrophia neonatorum,* which, though it may result from a number of prenatal causes, reaches its most striking development in hereditary syphilis. Such children rarely survive.

When the influence of heredity is manifested in a less virulent form the child may be born properly developed and apparently well nourished. In a few weeks lesions of the skin, mucous membranes, and eyes develop, corresponding in type to the expressions of acquired secondary syphilis; these are frequently associated with infiltrations of the viscera and bones, which pathologically belong to tertiary syphilis.

Following the first outbreak there is an intermediary period, lasting a year or eighteen months, till second dentition, till puberty, or even through life. It is mainly characterized by absence of symptoms. The general expression of the syphilitic diathesis is present, marked possibly by malnutrition, retarded development, wizened face, and sunken nose, but there seems to be little tendency towards renewed outbreaks of secondary lesions.

The tertiary stage, corresponding to the tertiary period of the acquired disease, manifests itself at the period of second dentition, about the time of puberty, or towards the end of middle life. Its lesions may, of course, develop at any time, and it may remain latent to the age of sixty (Fournier).

Skin and Mucous Membrane Lesions of Hereditary Syphilis

These correspond in general with those of acquired syphilis, but are more severe, and at times appear in the form of diffuse infiltrations. They vary somewhat in accordance with their time of appearance after birth. Those which are found at birth are most pronounced. Thus, it is not infrequent to observe a pemphigus so extensive that a greater part of the epidermis is involved and is shed in large strips. The mucous membrane is similarly affected at the same time. The lesion at birth may be pustular or ulcerative in type. In either case the arrest of development, hoarse voice, snuffles, and other signs of the disease are usually characteristic.

When the child is born apparently healthy, the symptoms not developing for some weeks, the skin eruption is commonly erythematous and papular in type, at least primarily, and coincidently with its appearance snuffles, sore mouth, hoarse voice, and general emaciation are noted.

Erythematous (roseolar) syphilides differ from those of the adult only in the fact that the epithelial layer of the skin is more readily macerated, particularly where the integument is creased or folded, as about the neck, the

genitalia, or the buttocks, and there results an abraded surface, presenting the appearance of a mucous patch.

Syphilitic roseola is apt to develop about the second or third week after birth, and first appears on the body in the form of small, oval, rounded, or irregular spots, dull red in color, and disappearing upon pressure.

Sometimes the eruption is confluent, covering large areas, with an almost unbroken sheet of dull red color.

It is frequently placed about the genitalia and on the face, thus differing from acquired syphilitic roseola.

The diagnosis of syphilitic roseola is sometimes difficult, as it may closely resemble simple erythema. The progress of the disease to the formation of papules, becoming scaly on the palms and soles, and the prompt yielding to mercurial treatment are characteristic features of syphilis.

Papular Syphilides and Mucous Patches.—These lesions are most marked upon the buttocks, palms, soles, and face, but may be diffused over the entire body. The small papules are situated in groups, sometimes rounded, more often irregular in shape, and tend to coalesce and form broad, flat papules. In the corners of the mouth they are converted into painful, bleeding fissures, which on healing leave permanent scars. These scars serve a useful diagnostic purpose in later life. Exfoliation is most marked in the plantar and palmar papular syphilides, which when confluent may cause the epidermis to be shed in large strips, exposing a thick, raw-ham-colored infiltration of the true skin. This corresponds in type to the plantar and palmar psoriasis of acquired syphilis, and may be complicated by painful cracks or fissures.

Papules when exposed to heat and moisture, as in the folds of the buttocks, lose their surface epithelium by maceration, become excoriated, and cause an offensive discharge. These mucous patches are formed most commonly about the anus or the angles of the mouth. Neumann states that they never exhibit the papillary overgrowth so common in the acquired disease.

The papular form of hereditary syphilide is much more obstinate to treatment than is the roseolar form of the disease.

Vesicular syphilide appearing in the form of small discrete blebs is usually associated with the papular and papulo-pustular lesions. When the individual vesicles are large, their contents soon become purulent. The small vesicles are grouped, and are placed on indurated papules. The eruption is rare, and is often a sign of severe infection.

Pustular Syphilide.—The lesions of this syphiloderm commonly succeed the papular eruption, though they may be noted at birth or may develop as the first symptoms. Frequently they do not appear until several years after the first outbreak.

The pustules vary in number, size, and depth in accordance with the severity of the disease. They are most frequently seen on the buttocks, thighs, scalp, face, hands, and soles, and are said to indicate the probability of the late tertiary outbreaks.

As in the adult, the pustular eruption may take the form of acne, impetigo, or ecthyma. Syphilitic impetigo is most frequent on the face and scalp. The axillary and inguinal regions are also seats of preference. Distinct, often deep,

ulceration beneath the crusts, and copper-colored infiltration of the periphery of the lesion, differentiate the syphilitic affection from simple impetigo. Syphilitic ecthyma attacks the buttocks and thighs by preference, forming large, flat, infiltrated pustules, the thick crusts of which conceal deep ulcers.

Nearly all these pustular lesions leave permanent scars; they may be complicated by cellulitis and gangrene, leading to wide-spread destruction of the skin.

Bullous Syphilide.—The bullous syphiloderm or pemphigus commonly appears on the soles, palms, fingers, toes, or limbs. The eruption consists of blebs more or less irregularly distended with liquid, which may be clear, cloudy, or bloody. It begins as dark, circumscribed infiltrates, from which the epidermis is shortly raised in the form of blebs.

These blebs are circular or oval in shape, sometimes irregular, are seated on inflamed reddish skin, are surrounded by a slight areola, and have a tendency to become confluent and spread. When a child exhibits such an eruption at birth or immediately after, the presence of syphilis should be strongly suspected, and will be quite certain if, in conjunction with the pemphigus, the general cutaneous surface is yellow or muddy in hue, is without elasticity or softness, owing to the absence of subcutaneous fat, and is for the same reason so furrowed and wrinkled about the face that the child presents an appearance of senility, and if there are also other syphilitic skin-lesions and the child has snuffles and a hoarse cry.

The appearance of pemphigus is ominous, denoting an extreme degree of poisoning by the syphilitic virus.

When the bullæ of pemphigus are filled with serum deeply stained with blood, there may be an associated hemorrhagic syphilis—that is, a form of the disease characterized by a purpuric eruption, by bleeding from the mucous membrane of the nose, mouth, and gastro-intestinal tract, and by visceral hemorrhages. The bleeding is due to syphilitic degeneration of the blood-vessels, especially the veins and capillaries. These hemorrhages, usually multiple and slight, are most likely to occur just after birth, at the time the cord is tied. Such cases are almost invariably fatal.

Tubercular and Gummatous Syphilides.—Tubercular and gummatous lesions may appear at any age, but are most common from the tenth to the twenty-ninth year. They may assume the dry or the ulcerative form, and usually exhibit a circular or circinate grouping. There is commonly but a single group. The seats of predilection are the face, particularly the nose, and the anterior surface of the leg. They appear in the form of painless, slowly increasing, raw-ham-colored infiltrations, which commonly ulcerate and are covered with thick crusts. These ulcers may heal, or may slowly extend, forming phagedænic or serpiginous lesions. Non-ulcerating infiltrations absorb, leaving atrophic areas; the ulcerating lesions leave deforming cicatrices: hence the importance of early recognition and prompt treatment of these syphilides. They closely resemble lupus, particularly when the face is attacked (Fig. 419).

Diagnosis.—The differential diagnosis between dry tubercular syphilide and non-ulcerating lupus is founded upon the dusky-red color of the syphilide and the firm induration. Tubercular nodules exhibit a more translucent, yellowish red, and are more yielding to pressure. (Fournier.)

The differential diagnosis between the ulcerating syphilides and lupus (Fournier) is founded upon:

1. *Areola.*—The areola of the syphilide is dusky red, that of the scrofulide is lighter, sometimes of a bluish tint.

2. *Crusts.*—Those of the syphilides are more homogeneous, more compact, thicker, and harder than those of the scrofulides. They are more frequently stratified and more deeply colored, almost black or greenish black.

3. *The Borders of the Lesion.*—In syphilides these are always sharply marked, elevated, infiltrated, punched out, and adherent. In lupus they are less distinctly outlined, are flat, soft, often reduced to a simple ulcerating circumference. They are not punched out, and are often loose and undermined.

FIG. 419.—Tubercular and gummatous ulceration of hereditary syphilis.

4. *The Base of the Ulcer.*—In tertiary syphilis this is deep, irregular, anfractuous, and exhibits a yellowish, adherent, semi-solid covering, representing the necrosed gummatous infiltrate. Lupus shows ulceration more on a level with the surrounding surface, with cherry-red granulations, sometimes exuberant, sometimes presenting a smooth glistening surface.

5. *Configuration of the Lesion.*—Often, but not invariably, the syphilitic lesions form a complete circle, a portion of a circle, or serpentine undulations. The ulcers of lupus are more irregular.

It is not, however, on these minor points of difference that the diagnosis will in the main be founded, but rather upon the method of evolution, the presence or absence of other more characteristic lesions, the previous history, careful physical examination of the patient, and the family history.

The gummatous syphilide when it appears as a diffuse eruption commonly undergoes rapid degeneration, presenting much the appearance of furunculosis.

Onychia of a dry and ulcerating form, and *alopecia,* are observed in connection with the skin-lesions of hereditary syphilis.

The lesions of the mucous membrane correspond in type with those observed upon the skin; thus, when pemphigus is noted, large or small raw surfaces will be found upon the mucous lining of the throat and tongue; when papular and papulo-pustular eruptions develop on the body, typical mucous patches will be found in the mouth—that is, superficially ulcerated infiltrations covered with a grayish necrotic membrane.

Not only the mucous membrane of the mouth and pharnyx but also those of the nose, ear, and larynx are liable to inflammation. Indeed, syphilitic coryza is one of the most characteristic and at the same time one of the most important of the early symptoms of syphilis, since by its interference with respiration it materially hinders the proper nutrition and development of the child. This condition of the nasal mucous membrane is shown by a thin, watery, irritating discharge, which dries in crusts about the nasal orifice; beneath these crusts are found excoriations and ulcers. The catarrhal swelling of the mucous membrane and the crusting produce so much narrowing of the air-way that respiration is difficult and noisy, the latter symptom giving the popular name " snuffles " to the affection. Mucous patches, erosions, and ulcers form on the lips, particularly at the angles of the mouth, and on the tongue, the gums, the palate, and the pharnyx. Caries and necrosis of the palate and of the nasal bones frequently complicate these ulcerations (syphilitic ozæna).

Fig. 420.—Syphilitic dactylitis.

The larynx is commonly affected, showing the infiltrations, erosions, and ulcerations noted on other mucous surfaces, and causing the characteristic hoarse voice. Exceptionally infiltration narrows the air-passage to the point of producing marked dyspnœa, or even death.

Later in the course of the disease—*i.e.,* after some years or about the time of puberty—typical tertiary manifestations may appear. These are similar to those observed in the adult. They are characterized by deep infiltrations, which exhibit a tendency to break down, forming ulcers, which are accompanied by few subjective symptoms. Their seat of predilection is the soft palate, but they are often found on the posterior pharyngeal wall, the anterior half-arches, and the hard palate. The mucous membrane of the nose is also affected, and the ulceration is extremely likely to extend to the underlying bone, producing great deformity or even complete destruction of the facial portion of this organ. The hard palate and the nasal septum are usually perforated.

Lupus rarely attacks either the mucous membrane or the bones of the nasal passages, being rather sharply confined to the regions of the anterior nares. In these respects it differs markedly from syphilis.

When tertiary infiltrations attack the larynx, destruction of cartilages may ensue, with deforming and crippling contractures, or the bronchi may be invaded, an obstinate form of bronchitis resulting. Spasm or œdema of the glottis may cause sudden death.

Hereditary Syphilis Affecting the Eye

Marginal blepharitis is sometimes encountered as a result of hereditary syphilis, appearing in the form of small irregular ulcers, usually near the corners. The treatment is cleansing and constitutional, together with the usual applications, particularly the ointment of calomel.

The lachrymal apparatus is sometimes involved from extension of inflammation dependent on caries of the neighboring bones.

Interstitial keratitis is the most characteristic eye-lesion of hereditary syphilis. This commonly begins as a slight diffuse haziness, situated in the cornea itself, not far from the centre, and at first affecting but one eye; usually the other eye is affected, but often not for weeks or months. The cloudy deposits lie in the cornea, and not on its surface, and first appear as diffuse spots; these later become confluent until the whole cornea is opaque, a bare perception of light remaining. There are usually photophobia and slight ciliary injection. The disease lasts for a varying period of time, weeks or months; then the cornea first involved begins to clear; the other cornea follows a similar course in time. In most instances there remains a slight permanent haziness, though vision is good. In severe cases the whole cornea becomes congested, blood-vessels developing in its substance. Cyclitis and retinitis are often associated with the corneal lesions, and in bad cases there may be secondary glaucoma and even shrinkage of the eyeball.

Fig. 421.—Hereditary syphilis. Cicatrices of fissured lips and gummata of the forehead and orbit. (De Schweinitz.)

Interstitial keratitis is rarely noticed in early infancy, but appears usually between the eighth and the fifteenth year, and in children presenting the typical physiognomy of hereditary syphilis.

Diagnosis.—This is in general easy to make. The ground-glass appearance in the early stages, and the dull pink or salmon color if the vascular stage is reached, are characteristic. In syphilitic keratitis the vessels are deep and closely interwoven, producing almost the effect of an ecchymosis. Moreover, in syphilis the disease is symmetrical, there is a tendency to spontaneous cure, ulceration hardly ever occurs, and there is but slight ciliary congestion. The grooves left by the new-formed corneal vessels are permanent, and their discovery by a magnifying glass long after other traces of keratitis have disappeared will often throw light on an obscure case.

The chief diagnostic point, however, is the association of this form of keratitis with other lesions of syphilis.

Iritis appears before the end of the first six months. It is later than the syphilodermata and of rarer occurrence, but it is extremely important, since, if overlooked, it may result in permanent impairment of the vision. When recognized it constitutes an almost pathognomonic sign of syphilis.

The *diagnosis* is readily made when attention is called to the eye, but the affection may be overlooked, since there are few subjective symptoms.

When the disease is fairly developed the pupil is irregular, especially under atropine; the iris is streaked with lymph, dull, swollen, and discolored. On very careful inspection a faint pink zone of congestion may be seen in the sclerotic, though this is often wanting.

The *prognosis* is generally good; even when the pupil has been occluded, vigorous treatment will cause absorption of the plastic exudate.

The *treatment* consists in the administration of mercury; it is often useful to give it in combination with tonics. When the disease occurs during intrauterine life, the infiltration is liable to extend to the lens, rendering it opaque; the same result often follows when the disease develops after birth and is not recognized. In this form of lens opacity the operation for cataract promises little good.

Optic neuritis, retinitis, and choroiditis are occasionally observed in the course of hereditary syphilis.

Hereditary Syphilis Affecting the Ear

Extension of inflammation from the throat and blocking of the Eustachian tube may cause chronic middle-ear disease, with consequent deafness.

The characteristic syphilitic otitis media is that which develops painlessly, usually within a few weeks or a few months of birth, and gives rise to no symptoms except a purulent discharge, thus differing markedly from the ordinary suppurative otitis media, which is not uncommon in infancy and childhood. This syphilitic otitis yields promptly and completely to specific treatment. If neglected it becomes chronic, producing irremediable changes, which result in partial deafness, suppuration of the mastoid cells, and bone-involvement.

Deafness is characterized by Hutchinson as one of the cardinal symptoms of hereditary syphilis. It is due to labyrinthine changes, usually affecting both ears. These changes in the case of an infant are unaccompanied by subjective symptoms, but result in deaf-mutism.

When the labyrinth is attacked later, at about the time of puberty, for instance, there may be as a premonitory sign painless tinnitus. Deafness develops rapidly, is complete, and is apparently causeless. Treatment is often unavailing.

Hereditary Syphilis Affecting the Teeth

The first teeth exhibit malformations and imperfections which are by no means characteristic of syphilis, but which may be referred to any inflammation of the gums sufficiently severe to interfere with the nutrition of the tooth-sacs. Thus, the teeth are often deficient in enamel, or this coating is unevenly

distributed, or is opaque and chalky, or the dentine is soft and friable, or the teeth are incongruous in size individually and relatively, and decay readily.

The permanent teeth may exhibit the same perversions of growth and nutrition as a result of stomatitis, whether this inflammation be produced by mercury, by gastro-intestinal derangements, or by local irritation. Mercurial teeth, for example, are irregularly outlined, horizontally seamed, honey-combed, scraggy, malformed, of an unhealthy, dirty yellow color, separated too widely, and deficient in enamel.

Fournier has written as follows concerning the influence of hereditary syphilis on the dental organs: The transmitted taint shows itself on the dental system in two series of manifestations, of very unequal diagnostic value: first, by retardation of evolution; second, by arrest of growth and modifications of structure.

Retardation of Evolution.—This generally applies to the entire first denture. In some cases it is limited to one group of teeth—the incisors, for example. A similar retardation sometimes is noted in the eruption of the permanent teeth. This is but a localized expression of the general lack of development characteristic of hereditary syphilis.

Arrest of Growth and Modifications of Structure.—Perversions of growth may be classified under dental erosions, microdontism, dental amorphism, and vulnerability. Some rarer peculiarities, such as irregularity of alignment and anomalies of reciprocal arrangement, are not included under any of the above headings.

The term syphilitic tooth implies a congenital dental malformation, a deficiency of development stamped by syphilis on the tooth yet unformed during the period of its intrafollicular evolution. The first dentition is not so often influenced as the second. The dental malformations are commonly multiple and symmetrical—that is, several teeth are affected, and usually corresponding teeth show similar lesions.

Dental Erosion.—This malformation may implicate any portion of the surface or borders of the tooth. Its common manifestation on the front of the tooth is a cupping, comparable to the slight depression which would be left by the point or the head of a pin in soft wax. These cuppings show a dark tint, grayish, brownish, or almost black, and in the deeper depressions enamel is entirely wanting. Erosions in this form are most common on the incisors, and notably on the superior centrals, and are often arranged in one or more horizontal rows.

The furrowed erosion is the commonest form, and appears as a transverse groove, which may make the entire circuit of the tooth, or may be broken. The groove may be so shallow as to form a scarcely perceptible streak, or it may be deep, as though filed, producing an unsightly deformity, since it soon acquires a dark tint. These furrows are always horizontal and usually single. Sometimes two or three are noticed on the same tooth, occupying the portion of the crown nearest the free edge. In such teeth the free extremity is generally worn thin, partly or totally deprived of enamel, rough, uneven, irregular, brownish, and rapidly wears away. These grooved erosions are most frequent on the incisors.

Surface erosion is rare. It represents simply an exaggerated form of the grooved erosion, covering a large surface of the crown and presenting a wide, unequal, and rough zone filled with alternate points and sinuosities and of a dirty yellow or blackish color.

The malformations affecting the cutting or grinding surfaces of the teeth present themselves under different forms, according to the class of teeth they affect.

The first molar is the only one among the grinders upon which the influence of hereditary syphilis shows itself. The body of the tooth for two-thirds or three-fourths of its height is normal; its upper surface is atrophied, suggesting a stump of dentine emerging from a normal crown. The masticating surface is rough and of a dirty-yellow or brown tint, and wears away, producing a flat surface with a yellowish centre and a peripheral border of white enamel. This short, flat tooth has a diagnostic significance of high value.

Upon the cuspids erosion of the free edge may appear as a simple notch, similar to a cut made in a piece of wood by two convergent strokes of a knife, or as a true atrophy, producing the appearance of a slender conical stump grafted in a cylinder.

Erosions of the cutting edge of the incisors are more numerous. There may be an angular notch, serration, atrophic thinning, with antero-posterior flattening, or general atrophy, the tooth presenting a normal base, from which emerges a small, rough, dirty-gray stump with an uneven surface.

Finally, there is the crescent-shaped erosion characterized by a semilunar notch, constituting the Hutchinson tooth. The important peculiarity of this last erosion is the semicircular cut in the free edge of the tooth. The superior central incisors are the teeth which exhibit this characteristic crescentic notch. It is impossible to mistake it or seriously to consider it in connection with any other affection of the dental organs. The crescentic notch is the essential characteristic of the Hutchinson tooth, but is not the exclusive one. The notch is nearly always bevelled at the expense of the anterior edge of the tooth; in other words, the anterior border of the crescentic arch is cut obliquely from above downward and from before backward. The typical Hutchinson's tooth is also marked by its rounded angles, the lateral and inferior borders merging by a curved line; it is much reduced in length; sometimes it is narrowed. Finally, the upper central incisors having the Hutchinson notch often deviate from normality in direction, and their axes in place of being parallel are obliquely convergent.

A perfect type of this tooth is best observed in youth. It does not protrude from the gum with a clearly cut notch, appearing first with this notch either partially or completely filled by small or apparently atrophied vegetations of the dental tissue. Deprived of enamel, these vegetations are rapidly destroyed, leaving in their place the smooth crescentic notch, the depth of which progressively diminishes with use. At twenty-five years the vault becomes nearly flat, but even then there remains the bevel of its anterior edge. Later with the wearing of the tooth the bevel disappears, so that beyond the age of thirty years Hutchinson's teeth are not to be found. This dental malformation commonly affects the two teeth symmetrically, often exclusively. Sometimes it

is observed in the upper lateral incisors, the inferior incisors, or even the cuspids. Hutchinson teeth are very rarely seen.

In the second dentition dental erosions are met with in the following order of frequency: first, on the first molars, particularly those of the lower jaw; second, on the incisors; third, on the cuspids. The bicuspids and second and third molars are almost invariably exempt from these erosions.

Erosions are usually multiple and nearly always symmetrical. Those of corresponding teeth maintain the same level on the crown.

Atrophy of the dental cusp, notably that affecting the first molar, and constituting the short, flat tooth, has a more precise meaning, because this is a favorite form of the malformation when caused by syphilis.

The best form—one which can be given as suggestive evidence of syphilitic heredity—is the semilunar notch of the free border of the central superior incisors.

Microdontism, implying an unusual smallness of the teeth, most frequently affects the superior and inferior lateral incisors.

Amorphism, or departure from normal shape, is almost as frequent as erosion. The teeth may present simply deviation of normal type, or they may be grossly malformed.

Erosion, microdontism, and amorphism may be associated. The tooth affected by syphilis is always vulnerable. Caries develops at an early age. The first molars being the teeth most exposed to these degenerations are often destroyed in youth. Irregularities of implantation are frequent, the teeth being often separated from one another by large empty spaces.

When the two upper central incisors are stunted, abnormally narrow at the cutting edge, crescentically rounded with the convexity upward, and the surface inclined upward and forward instead of backward, as in normal teeth, widely separated, but converging at their lower edges, they are indications of hereditary syphilis. Other lesions of the enamel or dental substance, possibly with the exception of the incomplete development of the first molar described by Fournier, although frequently caused by hereditary syphilis, may be due to other dyscrasiæ, and in themselves are not characteristic.

Hereditary Syphilis Affecting the Bones and Joints

The bones are more frequently involved in hereditary syphilis than in the acquired disease. They are usually attacked between the fifth and the nineteenth years of age (Fournier), by preference the bones of the cranium and nose and the long bones, particularly the tibia.

As in acquired syphilis, the essential lesions are those of periostitis, ostitis, osteomyelitis, and gummatous infiltration. They are usually formative rather than destructive in type.

Osteochondritis occurring at the diaphyso-epiphyseal junction of the long bones is pathognomonic of syphilis. It is characterized by a marked widening of the cartilaginous plate between the epiphysis and the diaphysis, by irregular growth of the bone layer just beneath the cartilaginous plate, and by softening at this point of juncture, allowing epiphyseal separation. Microscopically

there is found a proliferation of cartilage cells and an arrest in the transformation of these cells to bone.

The symptoms of this form of osteochondritis are as follows:

The bones most frequently attacked are the humerus, radius, ulna, tibia, and femur, but the ribs, sternum, and bones of the metatarsus and metacarpus are also often involved.

There is a swelling at the diaphyso-epiphyseal junction of the bone or bones involved, appearing in the form of a smooth ring or collar, which more or less completely surrounds the bone. In the course of some weeks, as the swelling becomes more pronounced, there may be a moderate amount of synovitis present, particularly when the disease is placed about the knee or the elbow-joint. At this stage—*i.e.*, that of overgrowth and infiltration—the lesion is readily influenced by specific treatment and well-regulated pressure.

If liquefaction of the infiltrate takes place there is complete separation of the epiphyses and diaphyses, shown by preternatural mobility and syphilitic pseudo-paralysis, the affected limbs losing all power. The lesions of osteochondritis are usually multiple.

The bones of the skull, particularly the parietal, frontal, and occipital, are affected by formative lesions.

Lack of symmetry is especially frequent and characteristic. Fournier has described a number of types: thus, there are the broad, high, bulging forehead; the bossed forehead, the projections on either side corresponding to the frontal eminences, with an apparent depression in the middle; and the keeled or chicken-breasted forehead, with a median projection. The asymmetry in these cases is due to formative osteoperiostitis of the frontal bones. When the parietal bones are affected there results the natiform skull, presenting apparent broadening of the cranium, with a central depression, suggesting the shape of the nates. When the nodes or exostoses are found in the regions of the frontal and parietal eminences they are often called " Parrot's nodes."

The degenerative lesions of the skull are characterized by swelling, softening, breaking down, and extensive ulceration and destruction of bone-tissue. After the first few years of life the cranium is rarely affected; the bones of the nose, however, are not spared.

When the bones of the nose and face are involved it is usually from an extension of disease, which primarily attacks overlying soft parts.

With regard to the long bones, the tibia is the telltale above all others. Swellings and nodes are the rule, deforming the diaphysis, either flattening out the crest or by bony deposits curving it. This sabre-shaped tibia is an important evidence of hereditary syphilis. The chicken-breasted thorax is also frequently observed.

Exceptionally syphilis manifests itself in the form of a rarefying ostitis, predisposing to fracture.

Diagnosis.—The bone-lesions of hereditary exostoses can be recognized by the fact that they are stationary, appear later than those of syphilis and are of larger size, are accompanied by no syphilitic history or symptoms, and resist specific treatment. Syphilitic osteochondritis, followed by separation of the epiphyses and complicated by suppuration and sinuses, may be mistaken

for a similar condition due to non-specific inflammations; the latter, however, occur much later in life, are attended with more acute inflammatory symptoms, and are not accompanied by other symptoms or traces of syphilis.

The characteristics of the specific and of the non-specific osteoperiostitis may be thus contrasted:

Syphilitic Osteoperiostitis.	*Non-Specific Osteoperiostitis*
Occurs in infants under three months of age.	Seldom, if ever, occurs in children under one year of age.
History of syphilis in child and its parents.	No history of syphilis; sometimes a history of traumatism.
Implication of other bones.	Usually confined to one bone.
Coincident with the development of the shaft of the bone.	Coexists with the ossification of the epiphyses.
Other lesions of syphilis—nodes, skin-eruptions, etc.	No such symptoms.
All the local symptoms comparatively mild.	Pain, redness, and swelling very marked.
Disease sharply localized.	Involves neighboring parts.
Lymphatics of limb unaffected.	Lymphangitis sometimes present.
Beneficial effect of specific treatment if employed early.	No such effect.
Wassermann positive.	Wassermann negative.

Rickets frequently complicates syphilis. As in the case with tuberculosis, which often runs its course in conjunction with hereditary syphilis, rickets is a distinct disease. It rarely begins in the first nine months, exhibits the prodromata of gastro-intestinal disturbances, sweating and hyperæsthesia, and in its progress epiphyseal enlargements, particularly of the ribs, bone deformity, delayed closure of the fontanelles, delayed dentition, and usually a failure to stand and walk at the normal period. The two conditions may be combined.

Syphilitic dactylitis commonly develops in infants. The infiltration may affect the subcutaneous and periarticular tissue, or the disease may begin in the bone or periosteum and later involve the fibrous structures about the joints.

The deep form is a specific osteomyelitis, and often destroys the bone and the articulation. The articular ends of the first phalanges are usually affected.

Symptoms.—Syphilitic dactylitis is characterized by the appearance of an ill-defined, fusiform, purplish swelling, which softens, breaks down, and discharges (Fig. 420). The lesions are often multiple, painless, affect the fingers rather than the toes, and in the more serious forms lead to destruction of tissue and marked interference with growth.

Diagnosis.—Specific dactylitis is not easily differentiated from tuberculous inflammation. In the absence of bacteriological or serological findings, or the corroboration afforded by associated symptoms, the distinction should be made by the test of treatment. This is supplemented by curetting or resection when abscesses have formed and dead bone is present.

The Joints.—Fournier describes a form of joint-involvement which he terms arthralgia, characterized simply by pain. It is apparently causeless, is irregular in onset, varies in degree, and has a tendency to become more severe at night.

The lesions of the joints are practically the same as those of acquired syphilis. Fournier describes three forms of arthrosis. The first presents the

appearance of simple chronic hydrarthrosis. Close examination shows that the affection of the joint masks a bone-lesion, perhaps an epiphysitis or a periostitis.

The second form presents the symptoms of syphilitic white swelling. There is a somewhat globular tumefaction of bony hardness made up almost entirely of an extensive hyperostosis of the epiphyses, aided by moderate synovial effusion. It is not sensitive and does not occasion pain. Function is not materially interfered with.

The third form presents deforming arthropathies dependent upon epiphyseal malformation. The shape of the swelling is irregular and at times extraordinary. Osteophytes materially interfere with function, and sometimes occasion complete ankylosis. When they are developed at an early age they are accompanied by muscular atrophy and arrested development of the affected part.

Hereditary Syphilis Affecting the Lymph-Nodes

The enlargement of the lymph-nodes is painless, slow, moderate in degree, and without tendency to suppuration. There is no progressive increment in size, nor do such enlargements present any diagnostic features. The anterior cervical group is most commonly affected.

Hereditary Syphilis Affecting the Nervous System

The Brain.—The lesions which attack the nerve-centres are, as in other regions, primarily vascular; macroscopically they may appear as diffuse infiltrations or gummata. They are usually multiple and diffuse, and with protean symptoms.

Paralyses are common. These may be limited or general; when they are repeated, multiple, or recurrent, and particularly when they involve symmetrical portions of the body, they suggest syphilis.

Infiltrations and gummata of the brain and its meninges have been observed at birth; they are shown later in case of survival by physical inaptitude, retarded development, impaired mentality, psychoses, headache, convulsions, paralyses. Pronounced cases are rare, because lesions sufficient to produce them are nearly always fatal in early life.

Late hereditary cerebral syphilis may cause persistent headache, intellectual asthenia, epileptiform convulsions, paresis, or paralysis. Its course may be rapid, corresponding to the symptomatology of acute or subacute meningitis or cerebral tumors, or may be chronic, lasting for several years.

Diagnosis.—It is apparent that cerebral syphilis has no individual symptoms of its own: hence the diagnosis will in the main be founded upon a history of syphilitic antecedents, the evidence of laboratory tests, and the effect of specific treatment.

The Spinal Cord.—Gummatous infiltration, as in acquired syphilis, may involve the membranes or the cord itself. The first symptom is usually paralysis of the legs. When the seat of involvement is high up the palsy may involve the arms also. Paraplegia, tabes, and disseminated sclerosis have been reported.

Hereditary Syphilis Affecting the Viscera

The Lungs.—The lungs are more frequently attacked by hereditary than by acquired syphilis. The disease may appear as gummata or as a diffuse infiltration.

Gummata of the lungs, the common form of involvement, affect chiefly the middle and lower posterior portions, appearing as miliary, pea-sized, sometimes cherry-sized, nodules.

Diffuse infiltration, the so-called white pneumonia, is often associated with gummata. It may involve several lobules or lobes. The portion of the lung affected is dense and of a lighter color than normal, due in part to the anæmia incident to perivascular connective-tissue growth with thickening of the vessel-coats. The alveoli are filled with epithelial cells undergoing fatty degeneration. Diffuse infiltration, if extensive, is necessarily fatal at birth. Children suffering from this lesion, even though it be limited, live but a few days or weeks.

Diagnosis.—The diagnosis of specific lung-involvement in syphilitic infants cannot be made. Many such infants perish of broncho-pneumonia; this, however, is an expression of vulnerability rather than of the localization of a specific lesion.

The Liver.—Examinations of children still-born because of hereditary syphilis show that lesions of the liver are most constant. The liver may be the only viscus involved. The usual form is a diffuse interstitial hepatitis, though true gummatous hepatitis may be observed at birth. There is marked enlargement, the liver, always disproportionately large in young children, being sometimes three or four times its normal size.

The only symptom which excites attention is the enlargement. Exceptionally, from obliteration of the bile-ducts, jaundice develops.

The Spleen.—The spleen is enlarged at birth or shortly after in about twenty per cent. of the cases of hereditary syphilis. The lesion usually appears in the form of diffuse interstitial splenitis, and may form a tumor three times the size of the normal organ. The increase in size seems to be mainly due to a simple hyperæmia. Enlargement of the spleen is a valuable aid to diagnosis. Moreover, the amount and persistence of the swelling give an approximate indication of the severity of the case.

The importance of splenic enlargement is greatest when noticed early—the first three months after birth—since at this period enlargement of the spleen due to rachitis can hardly come into question.

The Pancreas.—Diffuse interstitial infiltration of the pancreas has been found in a certain percentage of the more malignant cases of hereditary syphilis. There are probably no symptoms which will assist in the detection of this involvement during life, and it is always associated with lesions of other organs far more serious and demanding more immediate attention.

The Intestines.—During the early secondary period lesions corresponding in type to those appearing on the skin may attack the intestines. The passage of blood by the bowel would probably be the only sign on which a diagnosis could be formed. Ulcerating, gummatous infiltrations, rare in any event, are more common in congenital than in acquired syphilis, though it must be remem-

bered that this statement is founded on examinations of malignant and fatal cases of congenital syphilis.

The Kidneys.—Cassell reports six cases of albuminuria in thirty-one infants with inherited syphilis. Interstitial and peri-adventitial proliferation and cystic degeneration of the glomeruli were the lesions found.

Hereditary Syphilis Affecting the Testicles

This rare manifestation of hereditary syphilis usually develops in the first year of life. The testicle slowly and painlessly enlarges. The epididymis may be involved in the swelling, and there may be an associated hydrocele. Softening and ulceration rarely occur, resolution ultimately taking place, often followed by pronounced atrophy of the gland.

Diagnosis.—Non-traumatic enlargement of the testicle in infancy should always suggest syphilis or tuberculosis. If the tumor never reaches great size, shows no tendency to ulcerate, and primarily attacks the testis, it is probably syphilitic.

Prompt treatment will prevent atrophy.

Diagnosis of Inherited Syphilis

In reviewing the general course of a case of inherited syphilis it becomes evident that the differences between it and the acquired disease are seeming rather than real. The primary stage in inherited syphilis is of course wanting, and the tertiary stage is apt to appear unusually early.

Early Hereditary Syphilis.—The diagnosis of inherited syphilis in its early stages, at birth and shortly after, will be founded on—

1. A history of parental syphilis. The probability of the transmission of the disease is increased if the parental syphilis was recent at the time of conception.

2. A history of abortions or miscarriages on the part of the mother, particularly if such accidents have been frequent, or of the successive births of several living children who survived but a short time.

3. A fœtus or still-born child showing (*a*) osteochondritis, readily detected by splitting the long bones, particularly the radius, ulna, humerus, tibia, and femur, through the diaphyso-epiphyseal juncture. In place of the regular narrow line marking the apposition of bone to cartilage, there is a broad, irregular, yellow line; (*b*) enlargement of the liver and spleen; (*c*) the lesions of interstitial pulmonitis; true gummata, or catarrhal phenomena, with fatty degeneration; (*d*) papular, pustular, or ulcerating lesions, or bullæ which exhibit the characteristics of syphilitic pemphigus. Maceration of the epidermis and its elevation into bullæ are scarcely characteristic, though distinctly suggestive. (*e*) Arachnitis with hydrocephalus. (*f*) Arrested development and evidence of profound malnutrition.

4. A living child prematurely born, or carried to full term, showing the lesions of syphilis at birth or shortly developing them. Whether the syphilitic child be stunted, emaciated, wizened, and senile at birth, or be well nourished, cutaneous or mucous membrane eruptions and other evidences of syphilis are

often absent. In a few weeks, or at most two or three months, highly characteristic symptoms develop. The more prominent of these are snuffles, hoarseness of the voice, syphilides of the skin and mucous membrane, enlargement of the liver and spleen, inflammation of the iris, profound cachexia, and specific inflammation at the junction of the epiphyses and diaphyses of the long bones, sometimes producing a condition termed syphilitic pseudo-paralysis.

Upon the presence of these symptoms the diagnosis of hereditary syphilis will be founded in the first year in life.

Prognosis.—The prognosis of early hereditary symptoms is unfavorable if cachexia is marked, if the symptoms show themselves early, if the nasal or laryngeal affection is severe, if the eruptions are markedly bullar or pustulo-ulcerative, if the enlargement of the spleen is great, if the osseous lesions are multiple or extensive, and especially if lesions of the tertiary type develop such as gummata, nodes, etc. Moreover, the syphilitic infant is vulnerable to all forms of infection, and offers a feeble resistance against them. Hence, though living at birth, it usually survives but a short time.

Late Hereditary Syphilis.—After infancy the diagnosis of inherited syphilis will be founded on—

1. A history of parental or infantile syphilis, or both.

2. Imperfect or arrested development. This is manifested by many symptoms, none of which are individually characteristic, but the association of which is pathognomonic. The common expressions of this developmental retardation or arrest are—

(*a*) A low stature and puny development. The figure is often graceful and symmetrical, suggesting infantilism or early youth long after these periods have passed, or the appearance may be that of premature senility. (*b*) Pasty, leaden, or earthen complexion. (*c*) Dryness or harshness of the hair, and brittleness and splitting of the nails.

3. Active manifestations of syphilis or traces of former characteristic lesions. (*a*) The forehead bulging in the middle line, or bossed in the region of the frontal and parietal eminences. (*b*) A flat, sunken bridge of the nose, due to the coryza of infancy extending to the periosteum of the delicate nasal bones, interfering with their nutrition or partially destroying them. (*c*) Dulness of the iris (rare).

4. Ulceration of the hard palate and pharynx. Thickening or enlargement of the long bones near the ends, or slight angular deformity, the result of the osteochondritis of infancy.

5. Hutchinson's teeth.

6. Traces of interstitial keratitis.

7. Cicatrices about the lips and nares. These appear in the form of narrow, radiating scars, extending across the mucous membrane of the lips, or as a network of linear cicatrices on the upper lip and around the nostrils, as well as at the corners of the mouth and on the lower lip (Fig. 421).

8. Skin cicatrices, showing rounded, polycyclic, or serpiginous outlines, especially about the nose and the gluteal region.

9. Periosteal nodes on one or many of the long bones, or irregularly scattered over the skull.

10. Sudden and complete deafness without otorrhœa, or other subjective symptoms, or a history of sudden, painless otorrhœa in childhood.

11. In addition to lesions which are more or less characteristic of syphilis and are generally so recognized, retarded development, either mental or physical, usually both, imperfect coördination, persistent headache, epileptiform attacks, paralyses, and the symptoms of paresis and ataxia and disseminated sclerosis are often dependent on the vascular and perivascular infiltration and sclerosis of syphilis.

12. A positive Wassermann reaction.

Prognosis.—The prognosis of late hereditary syphilis is good so far as life is concerned, although exceptionally when important viscera, such as the lungs, the brain, the liver, or the kidneys, are attacked, death may result before treatment can accomplish resolution of the specific infiltrate.

The treatment of hereditary syphilis is given in Chapter XLIV.

CHAPTER XLIII

THE LABORATORY DIAGNOSIS OF SYPHILIS

THEORY AND TECHNIQUE OF THE WASSERMANN REACTION

The serum diagnosis of a disease depends upon detection in the blood of specific antibodies produced by the reaction of the body-cells to the virus of the disease.

If a foreign substance (antigen) be introduced in appropriate quantities into the body of an animal, an antibody will be formed in the blood-serum of the animal to overcome the action of the substance introduced, and the animal is said to be immunized. The antibody is specific only for the particular foreign material in question, and is known as amboceptor. This process of immunization applies to various substances; for example, different kinds of bacteria, red blood-cells, lipoids, etc. The reaction of the antigen with its specific amboceptor is brought about only in the presence of a third substance, known as complement. Complement, present normally in all blood-serum, comes into play in the reaction of any antigen with its specific amboceptor. This reaction is known as the complement-fixation reaction. Complement normally present in blood-serum is thermolabile; that is, it is destroyed by heating the serum for half an hour at 56° C. Amboceptor, on the other hand, is thermostabile, and is not destroyed by moderate heat. The reaction of bacterial antigen and its specific amboceptor is known as bacteriolysis, that of red blood-cells and hæmolytic amboceptor as hæmolysis, though there is no actual solution of the cells. In hæmolysis, the amboceptor binds itself to the stroma of the red cell, destroying the osmotic equilibrium between the blood-corpuscle and the surrounding fluid and causing the hæmoglobin to be set free and to enter the surrounding fluid, giving it a transparent red color, easily perceptible to the naked eye. In the case of bacteriolysis, or the complement-fixation reaction of syphilis, it is difficult or impossible to see that the reaction has taken place. Therefore, a hæmolytic system, the reaction of which can be easily seen, is introduced as an indicator. This application of the principle of hæmolysis was first made by Bordet and Gengou, in their serological experiments with cholera spirilla.

Nature of the Antigenic Substances.—Not only introduction of bacteria and red cells, etc., themselves can produce specific amboceptors in the blood-serum, but watery and alcoholic extracts of the bacteria, red cells, etc., can be employed for this purpose, and can be used as antigen. In the case of bacterial extracts the antigenic properties are probably contained in the protein material, while it is the lipoid substances in red corpuscles that possess the antigenic power. In the syphilis reaction, also, this property is probably carried by the lipoid substances.

In the preparation of a hæmolytic system for diagnostic purposes, the red blood-corpuscles of an animal—in the present case a sheep—are injected intraperitoneally or intravenously into a second animal—a rabbit—in increasing

quantities at intervals of a few days. By this means the blood-serum of the rabbit acquires a very high hæmolytic power for the red cells of the sheep, provided that a suitable amount of complement be present. Thus the rabbit's serum furnishes the amboceptor, and the sheep's red corpuscles the antigen, of the hæmolytic system.

The principles above described were first applied to the diagnosis of syphilis by Wassermann, Neisser, and Bruck, who, in the absence of pure cultures of the treponema pallidum, employed as antigen watery extracts of tissues very rich in treponemata, viz., the liver of a syphilitic fœtus. The results thus obtained apparently bore out the theoretical foundations of the reaction, though in reality the explanation of the reaction in syphilis is not the same as that in bacterial diseases in general, since alcoholic extracts of normal organs (human heart), in which no treponemata are present, can be used as antigen with as reliable results as extracts of syphilitic tissues. As it is lipoid substances in the tissues that are extracted by alcohol, it must be assumed that the antigenic properties are contained in these substances. Further, reliable results have been obtained by the use of articial lipoid as antigen. There is thus extracted from the organs an entirely non-specific substance, so far as treponemata are concerned, which combines with an amboceptor in the syphilitic patient's serum. Noguchi, using as an antigen strains of the *treponema pallidum* in pure culture, has demonstrated a positive Wassermann reaction in all the known syphilitic sera tested, and a negative reaction in non-syphilitic cases, thus proving that there is a specific complement-fixation reaction in syphilis as in the case of other bacterial diseases.

The above-described principles are applied to the diagnosis of syphilis as follows:

The suspected patient's serum, together with a definite amount of complement (see below) and extract of syphilitic tissue (antigen) are placed in a tube and incubated at 37° C. for one hour, or immersed in a water-bath for one-half hour at the same temperature. At the end of that time no visible change has occurred, whether complement has been fixed or not. To determine this point, sheep's red corpuscles and rabbit's serum possessing a high hæmolytic power for the sheep's corpuscles are added, and the tube incubated for two hours. At the end of this time, if no hæmolysis has occurred, it means that the complement has been fixed by the antigen and the antibody in the patient's serum, leaving no complement for the hæmolytic system, and the test is positive. If hæmolysis is complete, it means that there is no antibody in the patient's serum to combine complement with antigen; complement is therefore left free to bring about hæmolysis, and the test is negative.

Technique of Wassermann Reaction

Apparatus, animals, etc., required:

Electric centrifuge.
4 graduated centrifuge tubes, 15 c.c. (sterile).
4 plain centrifuge tubes (sterile).
1 per cent. solution of sodium citrate in normal salt solution (sterile).
Normal salt solution, 0.85 per cent. (sterile).

2 dozen capillary pipettes, made from ⅜-inch glass tubing (sterile).
Rubber nipples for capillary pipettes.
1 20-c.c. all-glass hypodermic syringe (sterile).
100 glass ampoules, 1 c.c. (sterile).
2 graduated glass cylinders, 100 c.c. (sterile).
2 flasks, 500 c.c. (sterile).
2 flasks, 100 c.c. (sterile).
1 centigrade thermometer.
Water-bath.
Bunsen burner.
Wax pencil for marking glass.
Triangular file.
Platinum wire, attached to glass rod.
Forceps, scissors, sterile gauze.
Ether.
95 per cent. alcohol.
100 test-tubes, capacity about 5 c.c. (sterile).
2 dozen 1-c.c. graduated pipettes (sterile).
2 graduated pipettes, 10 c.c. (sterile).
Copper boxes for holding pipettes.
2 wire racks for holding small test-tubes.
Racks for centrifuge tubes.
Incubator.
Sterilizer.
Ice-box.
Sheep.
Rabbits.
Guinea-pigs.

Preparation of Hæmolytic System.—The hæmolytic system employed consists of rabbit's serum immunized against sheep's red corpuscles. The preparation of the hæmolytic system should be undertaken first, as it sometimes requires four or five weeks. The immunity is brought about by injecting increasing doses of sheep's red blood-corpuscles into the peritoneal cavity of a rabbit at intervals of four or five days. The doses found to be suitable are 2, 3, 4, 5, and 5 c.c., approximately. After these injections a high dilution of the rabbit's serum will produce hæmolysis of a suspension of sheep's corpuscles in the presence of complement. The standard aimed at is hæmolysis of 1 c.c. of suspension containing approximately 1,000,000,000 sheep's corpuscles, by 1 c.c. of a 1–2000 dilution of rabbit's serum, in the presence of 0.1 c.c. of complement. Complement exists in varying quantities in all sera, and in order to have a fixed amount in the test the natural complement is destroyed by heating the serum over a water-bath at 56° C. for three-quarters of an hour. This process is known as inactivation of the serum. The complement used in the test is then added in definite quantity. For this purpose normal guinea-pig serum is used, as it has been found to be fairly constant in regard to complement content. Addition of complement to any serum previously inactivated is known as activation.

Collection of Blood from the Sheep.—For the first injection, about 6 c.c. of sodium citrate solution is placed in a graduated centrifuge tube, and brought up to 10 c.c. with the sheep's blood collected by puncturing a vein of the ear. The blood and the sodium citrate are well mixed and centrifuged. In ten minutes the red corpuscles should have collected at the bottom of the centrifuge tube, amounting in bulk to about 2 c.c. The supernatant clear fluid is drawn off with a capillary pipette, replaced with normal salt solution, and the whole shaken and then centrifuged for another period of ten minutes. This washing and centrifuging is repeated four or five times to remove all blood-serum, as injection of the latter might cause death of the rabbit from anaphylaxis. The corpuscles are then drawn up into an all-glass syringe and injected into the peritoneal cavity of a rabbit. At the end of four or five days a second injection, consisting of 3 c.c. of similarly prepared sheep's corpuscles, is made, and succeeding doses of 4, 5, and 5 c.c. are given at the same intervals.

A more rapid method of immunization is by three or four injections of ½ c.c. of 10 per cent. emulsion of sheep's corpuscles into the ear vein of the rabbit at the same intervals. By this method, also, a smaller quantity of corpuscles is required.

Titration of Hæmolytic Amboceptor.—Ten days after the last intraperitoneal, or five days after the last intravenous, injection the hæmolytic power of the rabbit's serum is tested. A vein in the ear of the rabbit is punctured, and 3 or 4 c.c. of the blood are collected in a centrifuge tube. This is allowed to clot, and the serum separated by centrifuging. The clear serum is drawn off with a capillary pipette and complement destroyed (inactivated) by heating over a water-bath for three-quarters of an hour at 56° C. Dilutions of the serum with normal salt solution are now made in proportions of 1–500, 1–1000, 1–1500, 1–2000, 1–3000, 1–4000, and 1–5000. One cubic centimetre of each of these dilutions is placed in a small, sterile test-tube with 1 c.c. of a suspension of sheep's corpuscles in normal salt solution in the proportion of 1,000,000,000 to the cubic centimetre, and 0.1 c.c. of the guinea-pig serum for complement. This mixture is then brought up to about 4 c.c. by the addition of normal salt solution, and thoroughly mixed by inverting the tube several times. The suspension of sheep's corpuscles is prepared by adding one part of whole sheep's blood to nine parts of sodium citrate solution, centrifuging, washing four times with normal salt solution, and bringing the total quantity up to the original volume (10 c.c.). In this way 10 c.c. of a uniform suspension of approximately 1,000,000,000 red corpuscles to 1 c.c. is obtained, as may be determined by actual count with the hæmocytometer. This method of preparing hæmolytic antigen is superior to that of making a 5 per cent. suspension of centrifuged corpuscles, which cannot be measured accurately on account of variations in the density of the emulsion of centrifuged corpuscles.

The mixtures of hæmolytic amboceptor (rabbit's serum), hæmolytic antigen (sheep's corpuscles), and complement (guinea-pig's serum) having been prepared, the tubes containing them, after being marked with the dilution of rabbit's serum in each, are placed in the incubator for one hour at 37° C.,

or immersed in a water-bath for a half hour at the same temperature. At the end of this time the tubes are removed from the incubator, and the one containing the highest dilution that shows hæmolysis is noted. If it be that marked 1–2000, the amboceptor is sufficiently powerful. If hæmolysis occurs only in tubes containing lower dilutions (1–1000 or 1–500), the rabbit requires further immunization with sheep's corpuscles, and one or two more injections of 5 c.c. are given, after which the titration is repeated. More than ten days should not elapse before repeating an injection. Hæmolysis is indicated by complete disappearance of the corpuscles, the fluid assuming a transparent red color. Absence of hæmolysis is shown by the corpuscles falling to the bottom of the tube, the overlying fluid being transparent and colorless. Various grades of hæmolysis are seen between these two extremes. When the rabbit's serum shows the required titre of 1–2000, the animal should be etherized and bled to death from the carotid artery, and the blood collected in a sterile flask. When the clot separates, the clear serum is drawn off, inactivated, and sealed in 1-c.c. sterile ampoules. If desired, the serum, before placing in ampoules, may be mixed with an equal quantity of glycerin, which is said to preserve it for a greater length of time. To avoid waste, an ampoule of the concentrated serum may be diluted with normal salt solution to a strength of 1–100 and kept in a flask on ice for immediate use, the further dilution necessary being made each time the test is performed. The power of the amboceptor can be maintained in this way for two or three weeks without deterioration, while that in the ampoules will keep for at least nine months.

A suspension of corpuscles should not be kept longer than three or four days.

Preparation of Complement.—In contrast to amboceptor, complement loses its power quickly and cannot be preserved. A fresh guinea-pig should be killed every time the test is made, and the serum used as soon as possible. It is only by using fresh complement that accuracy in the test is attained. The guinea-pig is etherized; before death occurs an incision is made in the neck, and the blood from the carotid artery allowed to flow into a sterile centrifuge tube. From 10 to 15 c.c. of blood should be obtained from one animal. After the blood clots it may be stirred with a sterile platinum needle, centrifuged, and the supernatant clear serum drawn off with a capillary pipette. The serum can then be diluted to form a solution of 1 in 10 with normal salt solution, so that small quantities of it may be handled accurately with a graduated 1-c.c. pipette.

Preparation of Syphilitic Antigen.—This is prepared by making either a watery or an alcoholic extract from the liver of a syphilitic fœtus. Non-syphilitic antigens, such as those prepared from normal liver, heart, etc., are used satisfactorily by some workers. The alcoholic extract of syphilitic liver prepared after the directions of Lesser is to be preferred. The amount to be used is determined by titration with a series of known positive and known negative sera. One-third of the amount that will fix complement by itself (*i.e.*, without the presence of antibody), is employed in the test. The dose is usually 0.2 c.c. of a five-times-diluted extract.

Collection of Patient's Serum.—The blood may be obtained either from a puncture wound in the tip of the finger, or from a vein through a needle. About 3 c.c. are required. When this has been obtained the tube is sealed with sterile cotton or a cork and placed on ice until required. Patient's serum should not be kept longer than six days before testing. When the clot separates the clear serum may be drawn off with a sterile capillary pipette and transferred to another tube. Sometimes the blood must be stirred with a sterile platinum needle and centrifuged before the serum can be removed. In removing the serum care must be taken not to draw any of the clot into the pipette, to avoid having any but sheep's red corpuscles present during the test, as the human clot would remain unchanged in the tube at the end of the reaction and possibly give rise to an incorrect reading.

On the day of the performance of the test the following procedures are carried out, as nearly as possible in the order here given:

1. Preparation of the suspension of sheep's corpuscles.
2. Inactivation of the patient's serum.
3. Titration of complement.
4. Performance of the test.

1. Preparation of Sheep's Corpuscles.—Inasmuch as this procedure requires a considerable length of time, it is started first. The corpuscles are collected and the 1,000,000,000 to the cubic centimetre suspension prepared as described. Sufficient blood should be collected to make 3 c.c. of suspension for each case, in addition to 4 c.c. for the known positive and negative controls, and 4 c.c. for titration of complement.

2. Inactivation of the Patient's Serum.—Destruction of complement normally present is brought about by placing the tube containing the serum in a water-bath at 56° C. for three-quarters of an hour.

3. Titration of Complement.—This is perhaps the most important part of the whole test. In order to have an absolutely accurate reading, we must know exactly the amount of complement that has been employed, as the quantitative estimation of antibody in the patient's serum is made by varying the amount of complement. In the original standardization of the hæmolytic amboceptor 0.1 c.c. of guinea-pig's serum was employed as complement. In the test we use the amboceptor in double strength, viz., 1–1000, and must ascertain the amount of complement necessary for this dilution. The sera of different guinea-pigs show slight variations in the amount of complement present. Thus, while 0.05 c.c. will generally be required for hæmolysis when using a 1–1000 dilution of amboceptor, yet at times a smaller or a greater quantity, such as 0.04 or 0.06 c.c., is the correct amount. In view of this it becomes necessary to ascertain the smallest amount of complement required to produce hæmolysis in the hæmolytic system every time the test is made. An excess of this would probably give a negative reading in a positive case. Fresh guinea-pig's serum is obtained and a 1–10 dilution made by adding one part of the serum to nine parts of normal salt solution. Into four tubes, each containing 1 c.c. of hæmolytic amboceptor (1–1000 dilution) and 1 c.c. of suspension of sheep's corpuscles (1,000,000,000), are placed 0.03, 0.04, 0.05,

and 0.06 c.c. of the diluted complement; 0.2 c.c. of antigen is also added to each tube to show that antigen alone will not interfere with hæmolysis. The tubes are now incubated at 37° C. for half an hour. The smallest amount of complement required to produce complete hæmolysis at the end of this time is employed in the test, and constitutes *one unit of complement*. This amount, as we have seen, is usually 0.05 c.c.

4. Performance of the Test.—If there is only one case, six tubes are required, one containing the serum to be tested, and the remaining five being controls, arranged in the wire rack in two rows.

Tube 1 in the front row contains 0.1 c.c. of inactivated patient's serum.

Tube 2 in the front row contains 0.1 c.c. of inactivated known syphilitic serum.

Tube 3 in the front row contains 0.1 c.c. of inactivated non-syphilitic serum.

To each of these is added 0.2 c.c. of syphilitic antigen and 1 unit of complement.

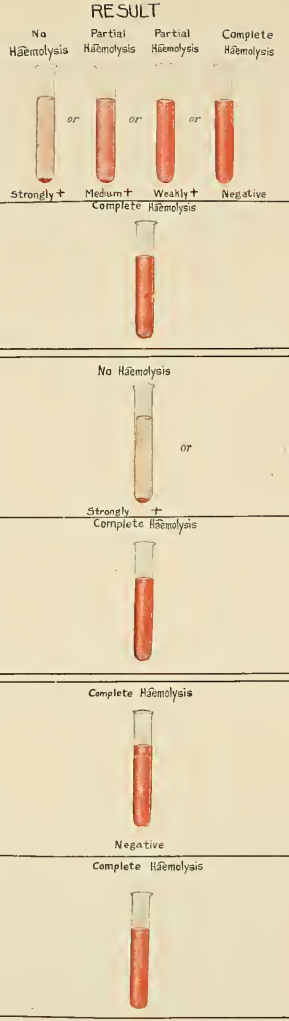
In the *back* row are three control tubes for Nos. 1, 2, and 3 of the front row, containing the three sera and complement in the same amounts, but *no antigen*.

The total contents of each tube are now brought up to 2 c.c. by adding normal salt solution, mixed by inverting, and the tubes placed in the incubator for one hour, or in a water-bath for a half hour, at 37° C., to permit of interaction of the antigen with antibody if present in the patient's serum, and consequent fixation of complement. The tubes are then removed from the incubator, and to each are added 1 c.c. of hæmolytic amboceptor (dilution 1–1000) and 1 c.c. of suspension of sheep's corpuscles (1,000,000,000). After mixing the contents by inversion, the tubes are again placed in the incubator at 37° C. for two hours. At the end of this time a preliminary reading may be made, and the tubes are set in the refrigerator over night, after which the final result is read.

Interpretation of Findings.—If the unknown serum is strongly positive, there should be no hæmolysis in tube No. 1 of the front row, because all available complement was fixed by the interaction of antigen and antibody in the patient's serum, none remaining for the hæmolytic system. For the same reason there should be no hæmolysis in tube No. 2 of the front row, containing the known syphilitic serum. In the remaining four tubes there should be complete hæmolysis. In tube No. 3 of the front row, containing known negative serum, there should be complete hæmolysis, because there is no antibody present in the serum to combine with the syphilitic antigen and fix complement, consequently the complement is left free to act with the hæmolytic system and hæmolysis results. This same reason would account for hæmolysis in tube No. 1 of the front row if the patient's serum were negative.

In the back row all tubes should show complete hæmolysis, because they contain no syphilitic antigen to combine with antibody if present in the patient's serum and fix complement; therefore, complement remains free to act with the hæmolytic system. Failure of complete hæmolysis in tube No. 1

					RESULT
Case to be tested	Tube 1 Front row	Patient's serum 0.1 c.c. Complement 0.5 c.c. Antigen serum 0.2 c.c.	Incubation 1 hr.	Amboceptor 1 c.c. Corpuscles 1 c.c.	Incubation 1 hr.
	Tube 1 Back row	Patient's serum 0.1 c.c. Complement 0.5 c.c.	at 37° C.	Amboceptor 1 c.c. Corpuscles 1 c.c.	at 37° C.
Positive Control	Tube 2 Front row	Syphilitic Serum 0.1 c.c. Complement 0.5 c.c. Antigen 0.2 cc.	Incubation 1 hr.	Amboceptor 1 c.c. Corpuscles 1 c.c.	Incubation 1 hr.
	Tube 2 Back row	Syphilitic Serum 0.1 c.c. Complement 0.5 c.c.	at 37° C.	Amboceptor 1 c.c. Corpuscles 1 c.c.	at 37° C.
Negative Control	Tube 3 Front row	Non-Syphilitic Serum 0.1 c.c. Complement 0.5 c.c. Antigen 0.2 c.c.	Incubation 1 hr.	Amboceptor 1 c.c. Corpuscles 1 c.c.	Incubation 1 hr.
	Tube 3 Back row	Non-Syphilitic Serum 0.1 c.c. Complement 0.5 c.c.	at 37° C.	Amboceptor 1 c.c. Corpuscles 1 c.c.	at 37° C.



Graphic portrayal of the "Wassermann reaction," demonstrating the results (1) in the case to be tested, (2) the positive control, and (3) the negative control.

of the back row shows that the serum in it contains substances capable of fixing complement independently of antigen, and the test must be declared negative, even though there should be no hæmolysis in tube No. 1 of the front row.

Various degrees of hæmolysis may occur in tube No. 1 of the front row, ranging from complete hæmolysis, indicating a negative result, to absence of hæmolysis, indicating a strongly positive result. Thus a slight degree of hæmolysis is read as a medium positive reaction, while still more hæmolysis is called weakly positive.

Quantitative Estimation.—Complete absence of hæmolysis indicates that the quantity of antibody present is capable of fixing at least *one unit* of complement. Stronger reactions than this can be measured by preparing tubes containing at the start two and three units of complement as well as one. Practically, it is not usual to carry the quantitative estimation beyond two units. For this purpose we place two tubes of patient's serum in the front row, tube (*a*) containing one unit of complement (0.05 c.c. guinea-pig's serum), and tube (*b*) containing two units (0.1 c.c.). In reading the end result, we may find no hæmolysis in tube (*a*), indicating a strongly positive result of one unit, and partial or complete hæmolysis in tube (*b*), showing that the antibody in the patient's serum was incapable of fixing two units of complement. Absence of hæmolysis in tube (*b*) indicates a reaction of two units.

In performing the test on more than one case, each tube containing patient's serum in the front row is numbered, and we must have a control behind it in the second row containing the serum but no syphilitic antigen. Of course, one positive and one negative control will answer for the whole series.

As a means of measuring the amount of hæmolysis in cases showing a positive reaction of less than one unit, the Duboscq colorimeter has been found useful. The contents of the control tube (back row) of each case are taken as the standard, or 100 per cent. hæmolysis. This is placed on one side of the instrument, while an equal amount of the fluid in the tube to be tested is drawn off from the undissolved corpuscles and placed in the other side. The screw is now turned until the two fluids have the same color, and the reading made. It is essential for accurate results that the original volume of fluid be the same in each tube. With the Duboscq colorimeter a difference in hæmolysis of 5 per cent. can be detected. In cases submitted for diagnosis, over 90 per cent. of hæmolysis should be regarded as negative; between 90 and 60 per cent. as weakly positive, between 60 and 30 per cent. as medium positive, and from 30 per cent. to 0 as strongly positive. In cases previously distinctly positive, in which the reaction is being used as a guide to treatment, from 90 to 95 per cent. of hæmolysis should still be regarded as positive. These cases should not be called negative until the slightest difference in hæmolysis in the two tubes has been obliterated by treatment.

The accompanying table will serve to illustrate the results of the reaction (Plate XIX):

Interpretation of the Wassermann Reaction

Barring the existence of a few diseases, noted below, the presence of a positive Wassermann obtained by the technique given is indicative of syphilis; however, in the absence of symptoms suggestive of the disease the diagnosis should not be made till after a second reaction has been performed, preferably by a different laboratory. A doubtful reaction (partial hæmolysis) may not be considered diagnostic under such circumstances. The diseases other than syphilis in which a positive Wassermann may be expected are yaws, malaria (during the febrile period), leprosy, relapsing fever, and the acidosis of diabetes. Pellagra is said to give a positive reaction when cholesterin is used as antigen.

The reaction commonly becomes positive in the primary stage of syphilis. Craig [1] gives the incidence in the several weeks of the chancre as follows: First week, 36.3 per cent.; second week, 59.3 per cent.; third week, 68.9 per cent.; fourth week, 77.2 per cent.; fifth week, 81.3 per cent. The same author thus gives the incidence of positive reactions in the several stages of the disease: Primary, 89.8 per cent.; secondary, 96.1 per cent.; tertiary, 87.4 per cent.; latent, 68.1 per cent.; congenital, 95 per cent.; paresis, 98 per cent.; tabes, 70 per cent.; cerebrospinal syphilis, 50 per cent. The percentage of positive reactions in the cerebrospinal fluid in these last diseases varies with the amount of fluid used; using 1 c.c. it is respectively 100 per cent., 95 per cent., and 100 per cent.; using 0.2 c.c., 75 per cent., 5 to 10 per cent., and 10 per cent.

The reaction becomes negative through the influence of specific treatment, of alcohol, and in some cases of time. Specific treatment acts by killing and diminishing the activity of the treponemata; also its presence in the system seems to have an effect on the reaction, so that it is inadvisable to take blood for a test within a month or six weeks of the administration of treatment. Craig and Nichols have shown that in many cases alcohol (240 c.c. of whiskey or 700 c.c. of beer, sometimes a smaller amount) will render a positive serum negative. The effect of the drug lasts about three days. With the lapse of time untreated cases may develop a negative reaction; also, it has been shown that the reaction may vary in intensity or quality from day to day—positive, doubtful, negative, etc. It is therefore quite improper to base a diagnosis on a single negative reaction; rather the reaction should be performed several times, preferably by a number of workers, and if possible before and after the administration of a "provocative" dose of salvarsan or neosalvarsan (0.2 to 0.4 Gm. of salvarsan or its equivalent), the blood being taken thereafter daily or on alternate days for a week, as the effect of the injection varies in different individuals.

Another cause of accidental negative reactions lies in infection of the serum with certain strains of staphylococci and streptococci.

The Hecht-Weinberg-Gradwohl Modification

The Hecht-Weinberg-Gradwohl modification utilizes the complement and anti-sheep hæmolytic substances in the patient's serum by not inactivating it. This does away with adding guinea-pig serum and an anti-sheep hæmolytic

[1] *American Journal of Syphilis,* 1917, i, 192.

amboceptor. It is claimed that some of the syphilitic antibodies are thermolabile and are destroyed by the process of inactivation. It is claimed also that 15 per cent. more positive reactions are obtained than by the old Wassermann reaction, and that thus negative results are more reliable than with the original Wassermann technique.

Use of Different Antigens

A large number of serologists employ more than one antigen routinely. It has been claimed that an alcoholic extract of human heart (normal) reinforced with cholesterin is more "sensitive" than the alcoholic extract of syphilitic liver, and will result in a greater number of positive reactions.

The cholesterinized antigen gives some degree of a positive reaction in 5 per cent. of known non-syphilitic cases. With some observers this discrepancy reaches as high as ten per cent.

RECOGNITION OF THE ORGANISM OF SYPHILIS

From the clinical standpoint, for the purpose of establishing the diagnosis, the *Treponema pallidum,* or *Spirochæta pallida* (according to whether the organism is considered a protozoön or a bacterium), may be sought for in the chancre and in the secondary eruptions of the skin and accessible mucous membranes. They appear as fine, closely, and regularly coiled spirals. Their extreme variations in length are from 4 to 24 microns, the usual length being between 7 and 10 microns; the number of twists varies from 3 to 30, the usual number being about 12. The organism is actively motile, the movements being described as of four kinds—a rotary motion on the long axis of the spiral, a bending of the filament, contraction and extension of its spirals, and progression through the medium in which it lies. The regularity of the undulations is quite characteristic, whether the organism is living or dead; stained specimens, however, are apt to be slightly less regular in this respect than are the living organisms.

Failure to discover the organisms, particularly in greatly indurated chancres, and those which have been treated with caustics, is not rare, so that single, and even repeated, negative examinations are only relatively diagnostic; should the lesion be clinically syphilitic, repeated Wassermann reactions should be performed in addition.

The examination may be made by means of dark-ground illumination, by Burri's India-ink method, or by means of stained smears, the methods being mentioned in the order of preference. Whichever is chosen, the material should be collected from the depths of the lesion, the secretion on the surface not being satisfactory. This is best done in the case of ulcers by washing off the surface with salt solution and then squeezing the lesion till a drop of serum appears; the serum may most easily be transferred to the slide by means of a capillary pipette. When there is no ulceration the epithelium may be gently scarified and serum expressed, or a vesicant may be applied and the serum used; as blood and pus interfere with the examination by obstructing the view, these should be eliminated as far as possible. To prevent infection, the surgeon's thumb and forefinger should be protected by rubber finger-cots, or the squeezing may be done by the patient.

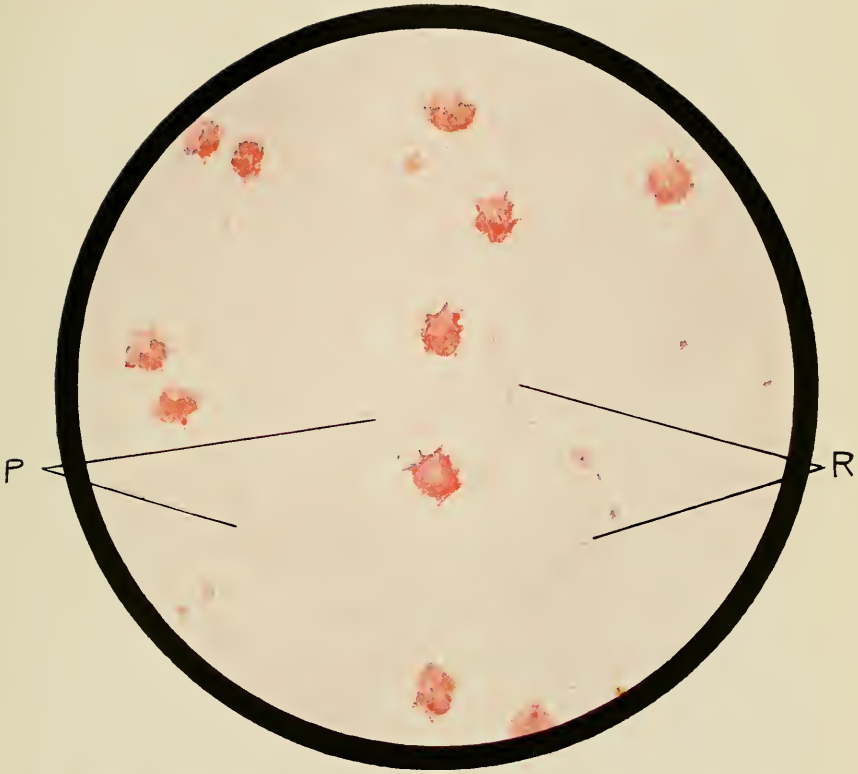
Dark-ground illumination is effected by means of a special substage, attachable to any microscope, whereby the rays of light are made to fall upon the object obliquely, so that only those rays which are refracted by particles in the field reach the eye. By this means it is possible to see such bodies as the *Treponema pallidum,* whose refractive index is so nearly the same as that of water that by ordinary illumination they are invisible. A drop of cedar oil must be placed between the condenser and the slide; the oil immersion is the best objective for the examination. The sun, a nitrogen-filled "stereopticon" Mazda lamp (100 to 250 watts), or a small arc may be used as the illuminant. Viewed by this method, the syphilitic organism appears as a white spiral on a black background. Its distinguishing characteristics are the slowness of its movements, it being very easy to keep it in the field; the regularity of its spirals; its tenuity, and its white color, certain other spirochætes having a yellowish hue, or even a reddish tint when slightly out of focus. The *Spirochæta refringens,* most often found associated with the *pallida,* is a longer, heavier organism, and less regular in its undulations. *Spirochæta gracilis* is not quite so slender as *pallida,* not quite so regular in its undulations, and a little more vigorous in its movements; in the mouth *Spirochæta dentium* may be a cause of error, but the fact that it is only about half the size of *pallida* should serve to differentiate them.

Burri's Method.—A drop of Günther-Wagner's Chinese water-proof ink is mixed with a drop of the suspected serous exudate at one end of a slide, and spread after the manner of spreading a blood film by means of the end of another slide. (To be entirely satisfactory, the ink should be sterilized and centrifugalized.) When dry, a drop of cedar oil is applied, and the slide is examined with the immersion objective. As the ink does not penetrate the spirochætes, these appear as delicate, white, undulating threads on a granular black background. Treated in this way, *pallida* does not straighten out as do most of the other spirochætes, but it is harder to judge its thickness than by dark-ground illumination, and the characteristic movements are, of course, lost. Five per cent. collargol may be used in place of the ink.

Stained Smears.—The *Spirochæta pallida* is stained with considerable difficulty, so that for this reason, and because it is time-consuming, this method is not recommended for purposes of diagnosis. Moreover, there may be some distortion of the filament in the process of fixing, so that it is more difficult to determine the nature of the organism. One of the best methods is that of Giemsa; the stain may be most conveniently prepared from the tablets of the Burroughs-Wellcome Company. By this method the *pallida* has a pink hue, while other spirochætes are a pale blue (Plate XX). Tribondeau's modification of Fontana's staining method is thus described by Harrison: "A thin film of the secretion, as free from blood as possible, is spread on a slide and allowed to dry. It is covered repeatedly for about a minute with the following (Huge's) solution:

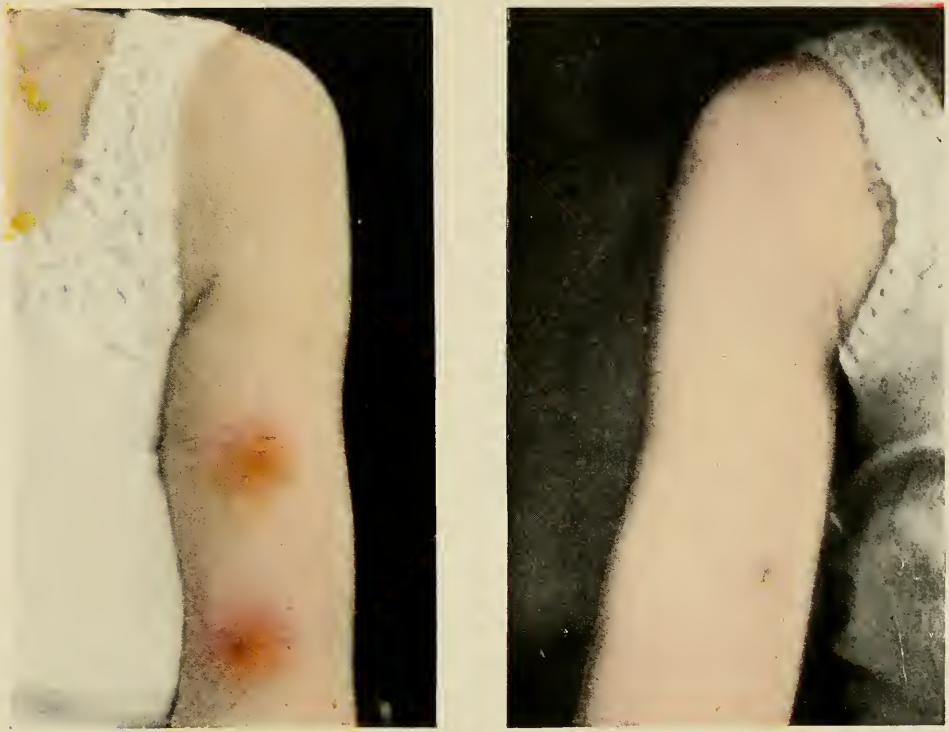
Pure acetic acid	1
Formalin, 40 per cent.	2
Distilled water	100

PLATE XX



Smear from chancre, stained with eosin-azur, by Leishman's method. The commercial tablet (Burroughs, Wellcome & Co.) is dissolved in 10 c.c. of pure methyl alcohol. A few drops are placed on the air dried film one to two minutes, then double the number of drops of distilled water are added and staining continued for five minutes longer. The film is then rinsed in distilled water, dried and mounted and examined under an oil immersion lens. Observe that the organism, P, of almost immeasurable thinness and regular undulations, is the *Treponema pallidum* (*Spirochæta pallida*); that, R, with the irregular spirals, also broader and more easily seen, is the *Spirochæta refringens*. The *Treponema pallidum* measures from 4 to 24 microns in length and averages about 0.25 micron in thickness. It possesses from 3 to 30, usually 8 to 12, spirals or undulations, characterized by their regularity. In morphology the organism resembles a tiny corkscrew with distinctly pointed ends. The *Spirochæta pallida* is actively motile and characterized by four different movements: a rotary; a lateral or wavy motion; progression forward or backward in the medium in which it lies, and a contraction and extension of the spirals. The *Spirochæta pallida* has been found in every lesion of syphilis, and is readily demonstrable in chancres and mucous patches, either by dark field illumination or stained smear. In tertiary manifestations, it is best demonstrated in the tissue by the method of Levaditi. It can be grown in pure culture, and certain of the lower animals, notably the chimpanzee, have been successfully inoculated.

PLATE XXI.



Luetin cutaneous reaction. Left arm demonstrates the papular character of the reaction on an erythematous, indurated base. Right arm shows the negative control. (Noguchi.)

To complete fixation alcohol is dropped on the slide and then flamed. The following mordant is then applied:

Tannic acid	5
Distilled water	100

warming gently till steam rises, and then allowing to act for 30 seconds longer. The specimen is washed under the tap for a few seconds, the excess water thrown off, and the slide then covered with Fontana's solution, which is prepared as follows: To a 5 per cent. silver nitrate solution ammonia is added, drop by drop, with a capillary pipette till a sepia precipitate forms and redissolves. To this solution more 5 per cent. silver nitrate is added till a solution is produced which remains slightly cloudy on shaking. The slide is covered with this solution, and gently warmed till steam arises; the solution is then allowed to act for 30 seconds longer."

Stained in this way, spirochætes appear dark brown to black. Such specimens fade in a few days under cedar oil or Canada balsam.

THE LUETIN REACTION

This is an allergic reaction produced by the intradermal injection of a substance called luetin, an emulsion of killed treponemata. After sterilization of the skin one or two injections of 0.07 c.c. of luetin are made, usually into the left arm. As a control, the other arm is similarly injected with an emulsion of culture medium. A very fine needle should be used to deposit the emulsion just beneath the epidermal layer, between this and the cutis vera.

Negative Reaction.—Noguchi states that in the majority of normal persons after twenty-four hours there appears at the site of the inoculation a small, erythematous area, which disappears within forty-eight hours, leaving no induration. Occasionally, after a day or two, a small papule may form, which begins to recede in three days and leaves no induration.

Positive Reaction.—Positive reactions may take the papular, pustular, or torpid forms. The papular reaction (Plate XXI) is characterized by a large, elevated, indurated papule, from five to ten millimetres in diameter, appearing in twenty-four to forty-eight hours. It may be surrounded by a distinct zone of redness and exhibit marked telangiectasis. The size and induration of the lesion increase for three or four days, after which the inflammation subsides. The color of the papule gradually becomes a dark-bluish red; the induration usually disappears within a week. The pustular reaction is similar to the above until the fourth or fifth day, when the papule becomes œdematous and may exhibit multiple miliary vesicles. Central softening occurs, and within twenty-four hours the papule is transformed into a vesicle, becoming definitely pustular. The pustule soon ruptures and the sore becomes covered by a crust, which falls off in a few days. This is the reaction most frequently observed in tertiary and treated secondary and hereditary syphilis. In the torpid reaction, rarely observed, the phenomena at the site of injection fade away in three or four days, but become relighted into a typical pustular reaction after ten or more days. Slight constitutional symptoms are noticed for twenty-four hours in most positive cases.

The reaction becomes positive later than the Wassermann, and is not so responsive to the changes brought about by treatment. It is claimed that it is especially valuable in those latent and late cases in which the Wassermann so often fails. This claim has not been largely substantiated. There are apparently many positive reactions in nonsyphilitic cases.

The administration of iodine renders the luetin reaction positive in normal individuals. The test is therefore totally unreliable in patients who have recently taken this element in any form.

EXAMINATION OF THE CEREBROSPINAL FLUID

Test for Globulin in the Cerebrospinal Fluid

In syphilitic disease of the cord and brain an excess of globulin is usually present in the fluid. This may be recognized by the butyric acid test of Noguchi. Four-tenths of a cubic centimetre of a ten per cent. solution of butyric acid is added to 0.1 c.c. of cerebrospinal fluid. This is boiled for a moment, 0.1 c.c. normal sodium hydrate added, again boiled momentarily, and set aside for observation. The reaction is read after ten or twenty minutes; positive (that is, with an excess of globulin present) if the fluid contains a coarse granular or flocculent precipitate; negative (normal) if there is merely a slight opalescence or a slight sandy precipitate. If the reaction is ambiguous it should be repeated, using double the quantity of fluid.

The Ross-Jones and Pandy tests have the advantages of being odorless, reliable, and sensitive. The former is performed by overlaying a solution of ammonium sulphate saturated at the boiling-point with a layer of cerebrospinal fluid. In the presence of a globulin excess a white ring forms at the line of contact. The Pandy test, slightly more delicate than the Ross-Jones, consists in adding one drop of the fluid to 1 c.c. of a saturated aqueous solution of phenol. The formation of a bluish-white ring or cloud indicates globulin excess.

Cytological Examination

In syphilitic diseases of the cord and brain there is more or less marked increase in the number of lymphocytes present. Polymorphonuclear leucocytes are not found. The freshly drawn fluid may be counted in any of the blood-counting chambers, but best in one of the larger ones, as that of Rosenthal. Counts of under 5 to the cubic millimetre may be considered as normal; counts from 6 to 9 as doubtful; and counts over 9 as positive.

Lange's Colloidal Gold Test

Certain substances in abnormal cerebrospinal fluids are capable of causing a "coagulation" or precipitation of solutions of colloidal gold, so that these solutions become more or less completely decolorized. Moreover, the dilutions of the cerebrospinal fluid in different diseases react differently, so that by using a series of dilutions more or less typical "curves" can be plotted.

The nature of the substance or substances causing the reaction has not been determined.

The method of applying the test is simple; unfortunately, the preparation of the reagent requires the greatest care, and is attended with so much difficulty that a number of men have been quite unable to prepare satisfactory solutions.[2] For the test a series of 11 test-tubes is used. In the first of these 1.8 c.c. of fresh 0.4 per cent. sodium chloride solution is placed; in each of the remaining tubes 1 c.c. of the same solution. To the first tube is then added 0.2 c.c. cerebrospinal fluid. After thorough mixing, 1 c.c. is withdrawn and added to the second tube, the process being repeated with all the tubes except the eleventh, which is used as a salt solution control. The dilutions therefore run from 1–10 to 1–5120. Five cubic centimetres of the reagent, colloidal gold, are then added to each tube, and the series set aside till the following day for final reading. It is customary to indicate the changes in the color of the solution by numerals from 0 to 5, 0 representing an absence of all change, and 5 complete decolorization; the "curve" then is indicated by a series of ten numerals, as 5555542100 (typical paretic curve), 0123310000 (luetic curve), 0001123531 (curve of meningitis, with greatest intensity in the higher dilutions), 0000000000 (curve of normal fluid).

[2] For details of preparation see article of Miller, Brush, Hammers, and Felton, *Bulletin of Johns Hopkins Hospital,* 1915, xxvi, p. 391.

CHAPTER XLIV

THE TREATMENT OF SYPHILIS

The treatment of syphilis is conveniently considered under the following heads:

1. Prophylactic.
2. Abortive.
3. Constitutional.
4. Local.

PROPHYLACTIC TREATMENT

A disease which owes its origin to a pathogenic organism which with few exceptions is carried by direct contact and usually during sexual approach, is, theoretically, entirely preventable.

The various Contagious Diseases Acts represent the attempts of the governing authority to protect the community at large from disease and infection by regulating the hygiene of and placing restrictions on the class most liable to spread the disease. These measures have been of great benefit, and it has been shown that clandestine prostitution, out of reach and control of these acts, is the major source of contagion in the countries in which such acts have been in force.

No method has as yet been devised which is in all respects unobjectionable or is capable of universal application. In the details of every plan yet proposed there has been much that was defective or positively harmful. The subject is still one of the unsolved sanitary problems of the age. The direction in which action must be taken, and the general character of that action, may, nevertheless, be indicated, if not demonstrated.

We may begin by urging the necessity of a more general and more accurate public knowledge concerning the gravity and the prevalence of this disease. The innocent—who are also in this respect the ignorant—members of the community have claims which we, who seek to fulfil the highest function of our profession—the preservation of health, individual and national—cannot conscientiously disregard.

Every adult citizen should be aware for his own sake of the possibilties of contamination which surround him; every parent should be competent to protect his wife or children from all indirect infection through a servant or playmate, a household utensil or a toy; every wife should know that by permitting the approaches of a syphilitic husband she herself becomes liable to disease, and to the creation of a being which has few chances for life and still fewer for health and happiness; and every syphilitic should realize that, except after certain intervals and under proper restrictions, his marriage is an outrage to the woman he professes to love and a crime against society.

Once let these facts be clearly understood and this information widely diffused, and an important step will have been taken not only in preventing

accidental and guiltless contagion, but also in preparing public opinion for the legislative measures which are believed to be desirable.

For these reasons we should in every proper way encourage the presentation of this matter to the community at large, by means, for example, of discussions in health societies, by proper representations to editors of the daily press, and by careful but truthful and forcible statements to our friends and patients, who are frequently eager for information on the subject.

It may be admitted at once that if the total abolition of prostitution could be accomplished, and if it could be followed by the conversion of the army of harlots into peaceful housekeepers or sisters of charity, and the transformation of their male patrons into pure, law-abiding citizens and fathers of families, it would be a most satisfactory consummation. No one, however, at the present day, with perhaps the exception of a few impractical clergymen and a number of enthusiastic and well-meaning but misguided women, believes in the possibility of attaining such an end. The accumulated experience of mankind constitutes a wall of unanswerable argument. All attempts at the extinction of prostitution present throughout the centuries one unbroken record of failure. Wherever this scheme has been tried, the sexual impulse, the strongest to which human nature is subject, has asserted itself, and other laws have been violated, other and graver evils have resulted. The remedy has proved worse than the disease (Lecky). Seduction, illegitimacy, criminal abortion, and infanticide have invariably followed, and the total average mortality of the community has been seriously increased.

In considering the necessity for general prophylaxis and the direction which efforts towards the accomplishment of this end should take, it should be remembered:

1. That syphilis is of great antiquity and is likely to continue indefinitely. 2. That this disease already affects a large number of the population (5 per cent.), and that by means of its many forms of inoculation and transmission it is rapidly spreading still farther. 3. That the existing means for its treatment among the poorer classes are insufficient, and that the establishment of institutions for that purpose or the endowment of special wards in our general hospitals is a measure eminently worthy of the attention of the public-spirited and benevolent. 4. That its most common mode of propagation is by irregular or illicit sexual intercourse, and that therefore we should turn our main efforts at prevention in this direction, while endeavoring at the same time and in every decent and proper manner to guard the community at large from the effects of ignorance. 5. That prostitution, arising in response to the demand for this illicit indulgence, has, like syphilis, existed from time immemorial, and is not likely to disappear. 6. That prostitutes themselves need protection and have claims on the humanity of the law. 7. That by means of legislation the syphilitic man or woman may be subject to a control which will promptly render him or her incapable of transmitting the disease by contact and reasonably assure an adequate curative treatment. 8. That there is sufficient evidence that such control, though surrounded with difficulties, is possible.

The only certain method of escaping the venereal forms of syphilis is the avoidance of exposure. When consulted in regard to prophylaxis the physician

should insist upon this point and need not volunteer further information, though under proper circumstances he should not withhold knowledge as to the means by which the danger of contagion can be lessened, if not entirely avoided.

This danger can be diminished by (1) avoidance of intercourse when there is an abrasion or any surface break about the genitalia; (2) the use of covers; (3) the local use of protective and antiseptic ointments; (4) thorough local washings with mild antiseptic lotions immediately before and immediately after coitus; (5) circumcision in persons with redundant or phimotic foreskins; (6) the use of astringents by those whose mucous membranes are particularly vulnerable; (7) immediate antiseptic applications to and superficial cauterization of abrasions acquired during coitus. The post-exposure method of protection which has seemed most efficacious is the rubbing of the part with a 33 per cent. calomel ointment, a small portion being also placed within the meatus. The inunction should be preceded by a thorough washing with soap and water; it is most serviceable when used immediately after intercourse.

The risks of extragenital infection are lessened by (1) the avoidance of prolonged contact of any portions of the body, this particularly holds true of the lips and tongue; (2) care as to the cleanliness of eating and drinking utensils, pipes, or any article which is liable to be contaminated by the discharge from the lesions of syphilitics; (3) the immediate cauterization of any abrasion or wound which could possibly have been infected by the discharges from syphilitic lesions.

Perhaps the most important means of prophylaxis is thoroughly to impress upon those who are suffering from florid syphilis the fact that any of the body secretions may carry the contagion. They must be instructed as to the possibility of infecting others from cigars, spoons, forks, or other articles moistened with their saliva, or from razors, manicure instruments, scissors, or knives which may be stained by their blood, and from handkerchiefs, sheets, pillow-cases, garments, towels, sponges, or baths which may contain the virulent discharge from mucous membrane or skin lesions.

The danger of conveying the contagion by kissing, by intercourse, or by body contact of any kind must be clearly laid down.

In the case of a surgeon, accoucheur, or dentist, the possibility of infecting patients by means of the blood incident to accidental wounds of the hands must be duly considered; indeed, this danger is sufficiently pronounced to forbid the performance of difficult or extensive operations during the florid stage of the disease.

As further means of prophylaxis, barbers, masseurs, chiropodists, all whose occupation requires them to treat the skin and its appendages by instruments or by the hands, should be thoroughly instructed as to the possibility of conveying the disease. They should be required to sterilize their instruments by heat or other efficient means before using them on each new client, and should be held legally responsible for cases of syphilis which develop in consequence of their ignorance or neglect of simple precautions.

Any community, state, or nation can lessen the incidence of syphilis to the vanishing point by—

1. Making the disease a reportable one.

2. Holding criminally responsible those who transmit it.

3. Keeping under supervision or, when needful, under confinement those capable of transmitting it until treatment rendering them harmless to the community has been applied.

Laws passed to this effect are, of course, futile and corrupting unless they be supported by the determined backing of the people, and particularly of the medical profession.

THE ABORTIVE TREATMENT

The two methods proposed for the abortion of syphilis immediately upon the appearance of chancre are—

1. The excision or complete destruction of the chancre and the surrounding tissues.

2. Destruction of the specific virus by immediate active constitutional treatment.

Excision or Destruction of the Chancre.—The abortion of syphilis by excision, cauterization, or injection of the chancre has been attempted in many hundreds of cases, but efforts in this direction have proved futile.

Aside from the attempt to abort syphilis, excision of the chancre may be undertaken with the idea of ridding the system of a focus of infection, or for cosmetic or other reasons, and if total excision does not leave a deforming or crippling scar it is a desirable procedure. The ulceration of chancre, even though it appear extensive and deep, usually disappears under constitutional treatment, leaving an insignificant scar.

When the sore is so situated that its removal by the knife would cause troublesome hemorrhage, deformity, or interference with function, constitutional treatment should be relied upon to effect its cure.

Even though the sore has not been seen for one or two weeks and the inguinal glands are typically enlarged, if situated upon a surface from which it can be removed without resulting deformity, it should be excised, the resulting wound being sutured. When situated entirely on the foreskin, whether seen early or late in its development, total removal by circumcision is desirable.

Constitutional Abortive Treatment.—The more prompt and vigorous the treatment with arsenic and mercury the more assured the clinical cure of the disease (see pp. 866 and 870). Hence treatment should be given as soon as the diagnosis of syphilis is made. The probable diagnosis is made on the history and the clinical findings, the absolute diagnosis is based on finding the treponema pallidum.

THE CONSTITUTIONAL TREATMENT OF SYPHILIS

General Hygienic Treatment.—The general health of the patient should be carefully regulated. He must be warned as to the importance of avoiding overwork, mental strain, undue exposure, and excesses of all kinds. He should eschew strong alcoholic drinks, but need not be prohibited from moderate indulgence in light wines at meals. He should be cautioned that the use of

tobacco distinctly predisposes to lesions of the mouth and throat, and should be advised to give up the use of this drug in all its forms.

The hereditary tendencies and diathesis of each individual should be studied, since every depressing influence by lessening cell-resistance may lead to increased virulence of the disease. Tuberculosis in the form clinically recognized as struma particularly favors virulent manifestations of syphilis, such as deep and obstinate ulceration, ostitis, caries, and various visceral changes. A tuberculous family history should, therefore, be regarded as a special indication for hygienic precautions. A patient with such a history should avoid all causes of local congestion, such as chilling of the surface, and particularly should guard against bruises, sprains, or other traumatisms, slight in themselves, but strongly predisposing to the local development of strumous and of syphilitic lesions. The diet should be rich, of digestible fats, and carbohydrates. Pulmonary gymnastics should be employed, and to the specific treatment should be added emulsions of partly digested cod-liver oil in combination with ferrous iodide or the hypophosphites.

Both the gouty and the rheumatic diathesis exert a distinctly unfavorable influence on the course of syphilis. They predispose to vascular degeneration, to cerebral disease secondary to endarteritis, to troublesome papulo-squamous syphilides, to iritis, to periosteal nodes, and various other affections of the fibrous tissue. The diet of such patients should be most carefully regulated. They should be told to eat sparingly of dark meats and of sugars, to drink freely of potash or lithia waters, and to eschew sweet wines, malt liquors, etc. In combination with the above treatment, short courses of salicylates may be advantageously employed, and the iodides should be begun much earlier than in the case of previously healthy patients.

Patients of a neurotic type seem to be especially predisposed to affections of the brain and spinal cord. The preliminary advice to such cases must be directed to the avoidance of mental strain of any kind. Every effort should be made to prevent that state of nervous depression which the knowledge of having contracted syphilis so often occasions. Rest to the mind, and diversions of various kinds, particularly those which require mild exercise in the open air, should be advised. Periods of rest are particularly desirable. The specific treatment may be advantageously supplemented by strychnine and the hypophosphites.

In all patients, whether robust or weak, the hygiene of the mouth, of the gastro-intestinal tract, and of the skin should receive particular attention, and invariably repeated examinations of the urine should be made to determine whether or not the kidneys can be depended on for the elimination of arsenic, mercury, and the toxic products of the syphilitic virus.

The teeth should be put in perfect order by a competent dentist, and should be kept scrupulously clean through the entire course of treatment by cleansing washes, astringent mildly antiseptic powders, and careful removal of particles of food by means of toothpicks and dental floss immediately after eating. Upon the health of the mucous membrane of the mouth depends to a great extent the ability of the patient to take an efficient quantity of mercury without causing salivation.

The gastro-intestinal tract must be kept free from irritation by well-regulated diet, by digestive and antiseptic powders, and by mild laxatives when indicated. Only when the stomach and bowels are in good condition can the full dose of the specific drugs be absorbed and eliminated without exciting symptoms of gastro-intestinal catarrh.

The skin aids in eliminating mercury. It should be kept in perfect health by daily bathing and friction, hot or cold water being employed in accordance with the feelings of the patient. Hot plunge baths, Turkish baths, and hot-air baths are to be advised, unless marked vascular degenerations contraindicate their employment.

The best indication of a patient's general health is his aptitude for work or play, and his enjoyment thereof, his digestion, sleep, and the maintenance of his normal weight.

Specific Treatment.—This is administered in as full doses as the patient can tolerate without prejudice to general health; the dose is regulated by the patient's susceptibility. The development of syphilitic lesions, even in the absence of a positive Wassermann, is indicative of inadequate dosage. The entire absence of lesions, a condition of general good health, and a persistently negative Wassermann, are indicative of a proper dosage. Loss of weight and general malaise may be indicative of either too much or too little specific treatment. The gauge of efficient treatment is the health of the patient. Frequently, as a result of treatment, there is an increase in general health, markedly beyond the degree enjoyed before syphilitic infection.

SYSTEMATIC TREATMENT OF SYPHILIS

The general hygienic treatment already described (pp. 863 to 865) is inaugurated at once; in addition, the patient's weight is recorded and repeated quantitative and qualitative examinations of the urine are made.

Arsenic and mercury should be given at once, usually in this order, regardless of the stage or age of the disease.

The always late cardiovascular lesions and some of the nervous manifestations call for a supplementary course of iodides.

The dosage should be as full as the patient can take without depressing him mentally, weakening him physically, markedly increasing or diminishing his urinary output, producing toxic symptoms, or lowering his weight; hence it must be based on a conservative guess.

The indications for conservatism are crippled kidneys or liver, or both, and, in the case of the arsenical preparations, an intense local or general spirochætal infection, particularly of the cerebrospinal system, under which circumstances the treatment should be inaugurated by mercury, on the theory that the salvarsan, in its destruction of the multitudes of spirochætes, may liberate a lethal quantity of endotoxins.

Arsenic given in the form of salvarsan or neosalvarsan causes prompt disappearance of spirochætes from a primary or secondary lesion; hence it renders them, in the course of a few hours, noncontagious. It also causes their prompt healing, a matter of a few days. Nor is the effect upon infiltrations which

have not been replaced by fibrosis less marked, though the action is necessarily slower.

The immediate effect of arsenic is at times an aggravation of local lesions expressed by an œdematous swelling (Jarisch-Herxheimer reaction); this is also observed after the use of mercury, but less often, and in milder form. Supplementary to arsenic, mercury is also given in all stages of the disease, the combination being more efficacious than either alone. In the late stages the iodides, because of their fibrolytic effect, are of distinct use, at times curative when other drugs fail.

TREATMENT WITH ARSENIC

Both salvarsan and neosalvarsan are dispensed in sealed glass capsules; exposure to air results in a rapid toxic decomposition. Salvarsan (34 per cent. arsenic), readily soluble in water, must, before injection, have its acidity neutralized. The addition of an alkali clouds the clear acid solution; further addition results in a clear alkaline solution which is injected into a vein, and promptly. The water used should be freshly distilled, *i.e.*, the day of use. The average dose is 0.4 Gm. (See method of administration, p. 868.)

Neosalvarsan, a yellow, water-soluble powder, bears to salvarsan in arsenic content the ratio of 2 : 3. The average dose for man is 0.6, for woman 0.45, for children 0.1, for infants 0.05.

The injection, given intravenously, is prepared by dissolving the contents of a capsule in water distilled the same day in Jena glass, with precautions against contamination. The usual dilution has been 25 c.c. of water for each 0.15 gramme of neosalvarsan. There have been no accidents fairly attributable to the use of a stronger solution, 0.1 gramme to 1 or 2 c.c., and this simplifies technique and lessens the occurrence of "water hazards."

Of these two drugs, salvarsan is perhaps the more popular. Our preference is for neosalvarsan because of the greater safety, greater ease of administration, and what has seemed equal efficiency. For the technique of injection see p. 871.

The contra-indications or conditions demanding conservatism in the employment of arsenical therapy by salvarsan and neosalvarsan or their substitutes are hæmophilia, Addison's disease, advanced visceral disease tending to inevitable early death, nephritis (other than luetic), myocarditis, arteriosclerosis, aneurism, diabetes and advanced disease of the central nervous system.

The local after-effects of properly performed intravenous injections are *nil.* We have seen but one case of phlebitis, and that symptomless. Should either of the drugs escape into the subcutaneous tissues through faulty insertion of the needle, or occasionally through leakage of the solution back beside the needle, between it and the wall of the vein, the fact is announced by the severe pain suffered by the patient. When the amount of fluid so misplaced is small, no lasting harm is done, the cellulitis subsiding under evaporating lotions and rest; when large, a more or less extensive slough may be produced.

Systemic after-effects from an arsenic injection are not usually observed, aside from the beneficial one upon the infection. The safety of the method is attested by its universal employment and the few accidents reported there-

from. Since the use of recently and properly distilled water as a solvent the, at one time, usual chill, fever, and vomiting, with some days' depression, are rarely noted. Even with every care, there will occur occasionally fullness and flushing of the face, vasomotor disturbances, suffocation sensations, pain in the teeth and gums, peculiar taste in the mouth, headache, nausea, rash upon the skin, abdominal and lumbar pain, slight jaundice, the symptoms of acute gastro-enteritis, hyper- or hypo-secretion of urine, nephritis, encephalitis; or a depressed vital condition which may persist for weeks. Such symptoms, provided the technique has been perfect, may be attributed to a hypersensitiveness to arsenic or to a breakdown in the usual detoxicating process. They are more commonly noted after the second or later injections than after the first. Exceptionally thromboses, local or pulmonary, and death have been observed.

Schamberg calls attention to the fact that there is a marked variation in the toxicity of different lots of the various arsenical preparations. Salvarsan and similar products cannot be purified by repeated crystallization, and for this reason it is probable that no two lots are ever identical in composition. The marketing of unduly toxic drugs can be avoided only by making careful biological tests of each lot.

Of the non-German preparations, novarsenobenzol (French), diarsenol (Canadian), and arsphenamine (Polyclinic) have given best results.

In cases of active cerebrospinal syphilis, death has resulted from a bloody exudate, with symptoms of acute meningitis. Badly crippled liver and kidneys have developed anuria. Under these circumstances the arsenic, if given, should be administered in small doses.

The dosage of neosalvarsan, since the original hope of Ehrlich has not been realized (*e.g.*, immediate and complete destruction of the invading microörganism), should be somewhat less than that originally advised rather than more, faith in its lasting effect being dependent upon repetitions rather than upon one massive attack. The stronger dosage has proved more dangerous and has shown no greater efficiency.

Given a proved or suspected syphilitic infection, three doses of neosalvarsan, from 0.45 to 0.9 Gm., or salvarsan, 0.3 to 0.6 Gm., are given at weekly intervals, in the absence of toxic symptoms; if these occur and are mild, the subsequent injection must not be given for a week or more after these have totally subsided; if they be severe, the dose must be cut in half and not repeated for a month or at all, particularly if there be signs of kidney irritation. Three weeks thereafter, the Wassermann reaction is taken, and if positive another series of three injections of neosalvarsan or salvarsan are administered and so on until the blood test is rendered negative. In the primary stage of syphilis three injections are usually sufficient to accomplish this, while in all cases with strongly positive or plus, 3 or 4 Wassermann reactions, as in the secondary, intermediate and tertiary stages of the disease, from six to twelve injections may be required to render the Wassermann negative. Rarely cases will be encountered, so-called " Wassermann-fast" patients, in whom it will be impossible to obtain a negative blood test. In such individuals recourse must be had to treatment with mercury and the iodides.

A psychic or physical persistent depression after injection calls for longer intervals, smaller doses, and a daily estimation of the total quantity of urine

passed in twenty-four hours; arsenic being a vascular poison and manifesting its early effects by polyuria, its late ones by anuria.

Coincident with these injections, mercury is given, preferably by inunction or intramuscular injection or by mouth (see pp. 871 to 874). This drug being an epithelial poison, its early toxic effects upon the kidneys will be shown by proteid and casts, hence urinalyses must be made for these abnormal elements. The mercury is given for six, nine, or twelve days in succession for four to six courses, with intervals of rest between each, half the length of the course, the dosage being such that the urine shows no abnormality, the appetite is good, and the patient's strength, cheerfulness, and initiative are normal. At the end of such a treatment the patient will be clinically well. Nor, aside from hygienic living and rational conservation of energy, is anything further needful till the end of six months, when a Wassermann is taken. Whatever its findings, the treatment should be repeated with dosage and intervals based on previous experience, but so planned as to come well within the patient's tolerance. In another six months the treatment is repeated again, even if the Wassermann has been both times negative, cutting the dose in half; this can be done by lessening the number of injections and inunctions. After the Wassermann reaction of the blood has been rendered negative by intensive treatment with arsenobenzol (arsphenamine) administered in series of three injections and supplemented by active mercurial treatment, including the iodides in the tertiary stage of the disease, for one to two years, forced treatment may be suspended, providing in all cases after the onset of secondaries, or with symptoms referable to the central nervous system, or with ocular manifestations or in those previously exhibiting a strongly positive blood Wassermann, the spinal fluid is also found to exhibit a negative Wassermann and normal lymphocyte count. Thereafter through life the patient should take, spring and fall, for one month, mercury in doses about two-thirds those which he took and tolerated in the early stages of his infection. Negative blood and spinal fluid examinations must be demanded indefinitely, certainly for two or three years after the suspension of active treatment, before the patient can be discharged tentatively as cured or qualified for matrimony.

To this general rule of treatment there are exceptions:

1. Chancres seen early, that is, before the advent of a positive Wassermann, treated intensively by salvarsan or neosalvarsan may be promptly cured, without the aid of mercury; if seen late after the Wassermann has become positive, mercury in accordance with the general principles outlined above should supplement the arsenobenzol. Thereafter treatment may be omitted if the Wassermann taken yearly for two years is negative and the patient remains free from symptoms. There is reason to believe that an early searching treatment radically cures most of these cases.

2. The treatment should be more intensive and more frequently repeated if lesions surely syphilitic and curable do not disappear.

3. Cerebrospinal infections, or those which are intense and widespread, may contra-indicate the use of salvarsan or neosalvarsan. Invariably mercury and the iodides are most important in the treatment of cerebrospinal syphilis and should always supplement the arsenic preparations.

4. Cases in which either arsenic or mercury, even in small doses, produces toxic effects should be treated by the one of these drugs which is the better tolerated.

5. More harm than good may be done in old latent cases, evidenced only by a positive Wassermann, by resort to hyper-intensive arsenical treatment.

The routine treatment of syphilis may be managed by the adoption of one or the other of the following outlined methods:

Intensive Arsenical Treatment Supplemented by Mercury and the Iodides

Primary

Wassermann Negative

Week of treatment	Intravenously 606 or 914 Gm.	Gm.
1	0.5	0.75
2	0.6	0.9
3	0.6	0.9

Thereafter blood to be examined in three weeks, and if negative at three monthly periods for a year.

Wassermann Positive

Week of treatment	Intravenously 606 or 914 Gm.	Gm.
1	0.5	0.75
2	0.6	0.9
3	0.6	0.9
6	Wassermann, and if positive	
	0.6	0.9
7	0.6	0.9
8	0.6	0.9
11	Wassermann, and if negative courses of mercury by mouth, inunction, or intramuscularly for six months. Thereafter blood to be tested at three monthly periods for a year.	

Excise chancre or dress or rub away with calomel ointment.

Secondary

Week of treatment	Intravenously 606 or 914 Gm.	Gm.
1	0.5	0.75
2	0.6	0.9
3	0.6	0.9
4	0.6	0.9
5	0.6	0.9
6	0.6	0.9
9	Wassermann, and if positive	
	0.6	0.9
10	0.6	0.9
11	0.6	0.9
14	Wassermann, and if negative examination of spinal fluid, and if positive another series of 606 or 914 until rendered negative. Thereafter, mercury in courses by inunction, intramuscularly, or by mouth for one or two years. Thereafter blood tests at three-month intervals the first year, at six-month intervals the second year, and yearly thereafter. The spinal fluid should be examined yearly or as a final control.	

Tertiary

Week of treatment	Intravenously 606 or 914 Gm.	Gm.
1	0.5	0.75
2	0.6	0.9
3	0.6	0.9
4	0.6	0.9
5	0.6	0.9
6	0.6	0.9
9	Potassium iodide in ascending doses for three weeks.	
14	Wassermann, and if positive	
	0.6	0.9
10	0.6	0.9
11	0.6	0.9
	Potassium iodide in ascending doses for three weeks.	
14	Wassermann, and if negative, examination of spinal fluid, and if positive further series of 606 or 914, until rendered negative, or that impossibility becomes apparent. Thereafter iodides and mercury by inunctions, intramuscularly or by mouth for two years. Thereafter mixed treatment fall and spring throughout life. Blood and spinal fluid should be examined at yearly intervals and positive findings indicate further treatment by 606 or 914.	

Intensive Arsenical Treatment Associated with Mercury[1]

First Course

Day of treatment	Intravenously 914* or 606* Gm.	Gm.	Mercury Cyanide or Grey Oil
1	0.45	0.3	
2			0.01†
3			0.01
4			0.01
5	0.06	0.4	
6			0.01
7			0.01
8			0.01
9	0.75	0.5	
10			0.01
11			0.01
12			0.01
13			0.01
14	0.9	0.6	
15			0.01
16			0.01
17			0.01
18			0.01
19			0.01
20	0.9	0.6	
21			0.01
22			0.01
23			0.01
24			0.01
25			0.01
26			0.01
27	0.9	0.6	
28 to 33	No treatment		
34	0.9	0.6	
35			0.1‡
36 to 40	No treatment		
41	0.9	0.6	
42			0.1

Rest for 30 days.

Second Course

Week of treatment	Intravenously 914* or 606* Gm.	Gm.	
1	0.45	0.3	0.1‡
2	0.6	0.4	0.1
3	0.75	0.5	0.1
4	0.9	0.6	0.1
5	0.9	0.6	0.1

Rest for 2½ months.

Month of treatment	
6	Wassermann (blood and spinal fluid).

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[1] Obviously in the tertiary stage of syphilis the iodides are also employed.

* 914 or 606, used as a convenience and does not refer solely to the original German products.

† 1 per cent. solution in ampoules of 1 c.c.

‡ 40 per cent.

Third Course

7	(Same as "Second," regardless of Wassermann)
	Rest for 3 months.
10	Wassermann (blood and spinal fluid).

Fourth Course

11	(Same as "Second")
	Rest for 4 months.

Year of treatment	
1	Wassermann (blood and spinal fluid).
	If negative—no treatment.
	If positive—repeat "Second" course.
1½	Wassermann (blood and spinal fluid).
2	Wassermann (blood and spinal fluid).
	If negative—no treatment.
	If positive—repeat "Second" course.

Administration of Salvarsan and Neosalvarsan

Certain precautions are needful for the safe administration of these preparations. The water in which they are to be dissolved must have been freshly distilled in a Jena glass retort, and sterilized immediately thereafter. The apparatus used must be rinsed off after sterilization with distilled water. The drugs must be dissolved immediately before administration, as toxic decomposition occurs if they be permitted to stand. The intravenous administration only is described as intramuscular and subcutaneous injections are unjustifiably painful.

Injections are usually made by hydrostatic pressure, the apparatus consisting of a burette, four feet of rubber tubing, and needle (Fig. 11). The burette should be of about 300 c.c. capacity, and should be graduated in 25-c.c. divisions; a glass stopper and stopcock are convenient additions; permitting laying the burette down after filling; a much smaller burette, 100 to 150 c.c., is large enough for the administration of neosalvarsan and arsphenamine. In using salvarsan it is convenient to have a thermometer inserted at this point. A platino-iridium or gold needle, 20-gauge, is most serviceable. A slip-joint connection to the tubing is a convenience, as is a cock; a spring clip on the tubing close to the needle answers every purpose. The needle's point should be carefully ground; whether the point is long or short is a matter of individual taste. Other necessary utensils are a glass mixing cylinder (50 c.c.), a rod thermometer, and a strip of rubber dam, 12 by 3 inches; and if salvarsan is to be used a small glass funnel, medicine dropper, and 15 per cent. solution of sodium hydrate. Freshly distilled water and saline solution (0.9 per cent.) made with chemically pure sodium chloride and freshly distilled water must also be provided (Fig. 422).

Preparation of Salvarsan.—The distilled water and saline solution are warmed to a point somewhat above that of the body (110° to 120° F.), that they may be delivered to the needle at about 100°. The apparatus is rinsed with one of the solutions, and the tubing and needle are filled with saline solution. The salvarsan, say 0.4 Gm., is dissolved in 30 or 40 c.c. of distilled water in the mixing cylinder by vigorous shaking, neutralized by adding about 16 drops of the hydrate solution (it is well to add about 12 drops first,

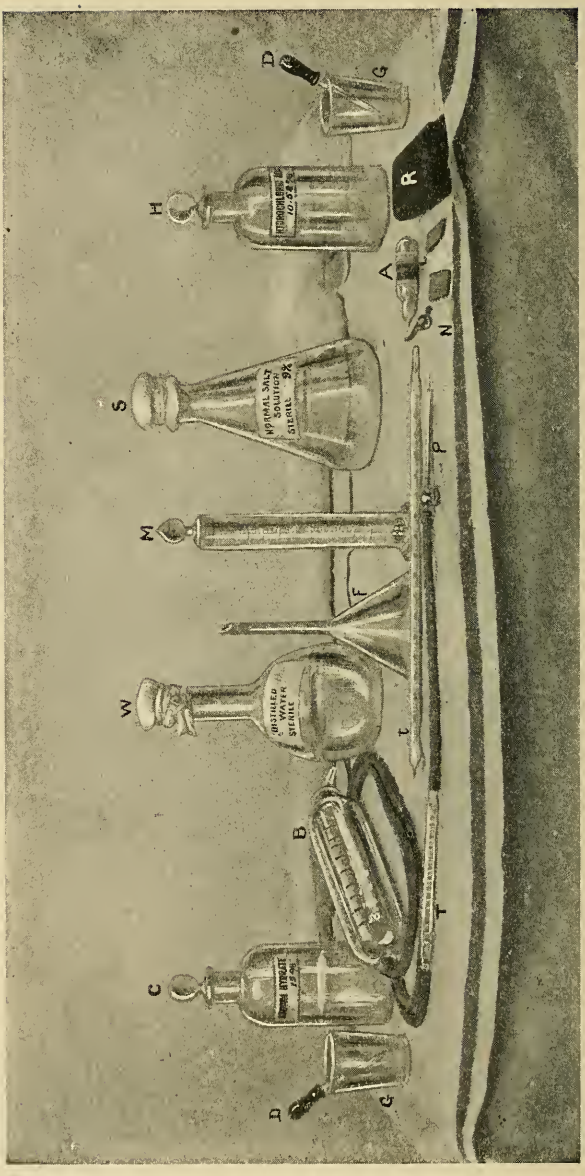

FIG. 442.—Showing various reagents, solutions, glass vessels and apparatus ready for preparation of salvarsan or neosalvarsan.

causing a marked turbidity of the solution, and then to continue the addition a drop at a time, shaking after each addition, till the solution becomes once more clear; should too much alkali be added, the mistake may be corrected

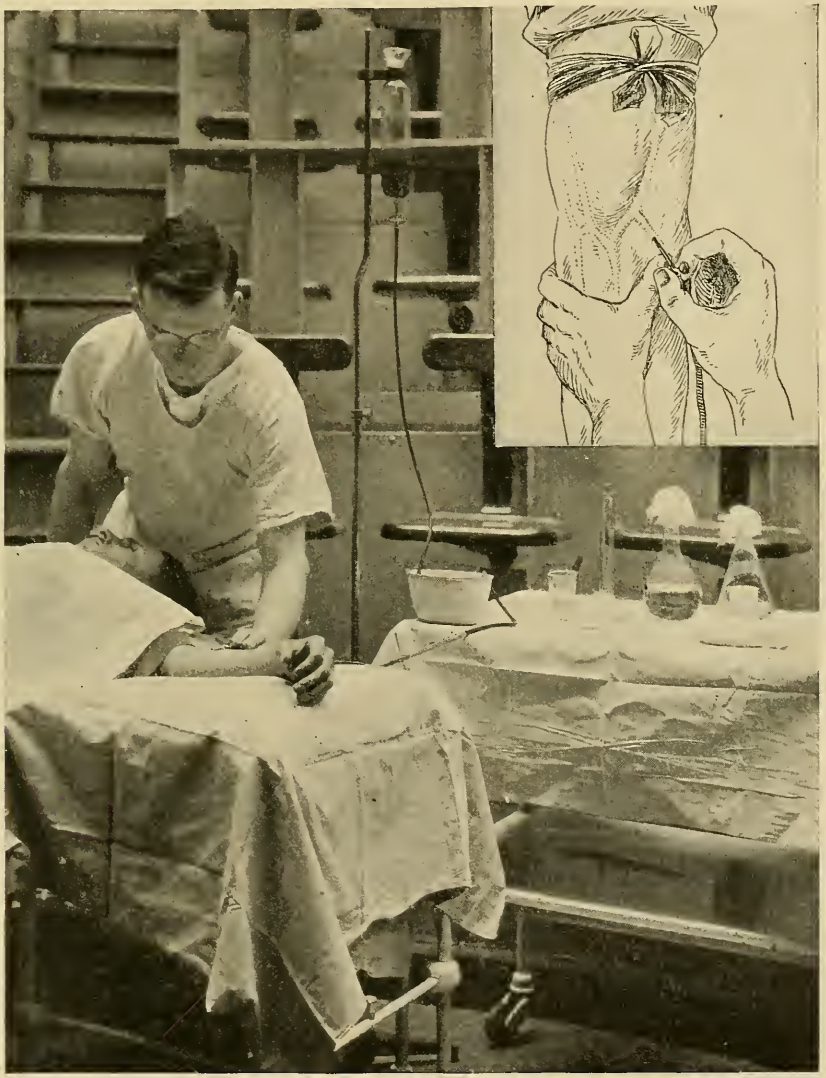

FIG. 423.—Arrangement of patient and tables for administration of salvarsan or neosalvarsan. Note the easily applied and released rubber dam tourniquet shown in the corner sketch, also the manner of fixing the skin overlying the vein with the thumb or index finger as the needle is introduced into the vein. Observe the basin of hot or cold water containing section of tubing, thereby readily controlling temperature of injected solution.

with a few drops of dilute hydrochloric acid). This solution is now poured into the burette, filtering it through sterile cotton, and the bulk brought up to 200 c.c., either with 0.5 saline solution, as generally advised, or more con-

veniently with a mixture of water and 0.9 per cent. saline solution (5 parts saline solution to 4 parts water). The veins of the patient's arm are made prominent by fastening about it a strip of rubber dam, and the needle passed through the skin into one of these vessels (Fig. 423). Should the operator be in doubt as to whether a vein has been entered, the needle may be disconnected, when a flow of blood will announce the fact if the needle is in the proper position. The tourniquet is then removed and the solution allowed to flow, the speed being so regulated by the elevation of the burette that about eight minutes is required for the delivery of the dose. When the surface of the solution is at the neck of the burette, saline solution is added to wash out the vein.

There are very few cases in which it is impossible to enter a vein as indicated above. Occasionally, however, in fat individuals with small veins the needle cannot be properly inserted. It is then necessary to expose a vein under infiltration anæsthesia and insert the needle by the sense of sight. A vein in the lower extremity should be selected when possible to avoid conspicuous scarring.

Preparation of Neosalvarsan.—This differs from that of salvarsan in that the drug is given in cold solution (68° to 72° F.), in that the addition of an alkali is unnecessary, in that a smaller amount of solution is used (from 10 to 150 c.c. for a dose of 0.9 Gm.), and in that shaking is not permissible in preparing the solution, nor any delay in the administration, once solution has been effected, the drug being much more easily decomposed than the older preparation. It has been our custom, in order to avoid delay, to partly fill the burette with saline solution, insert the needle, and prepare the solution by very gently inverting the mixing cylinder while the saline solution was flowing into the vein.

Administration by Means of a Syringe.—Neosalvarsan may be administered in concentrated solution by means of a 20-c.c. glass syringe. The method reduces the amount of fluid injected, and, provided the injection is made slowly, so that approximately the same time is consumed as in giving the larger bulk, seems to be attended with no added risk. It is claimed that reactions are less likely to occur. Assurance may be had that the needle is in the vein either by slightly withdrawing the plunger of the syringe, or by disconnecting the needle. Thompson has devised an ingenious device for washing the vein after the injection by connecting two syringes to the needle by means of a three-way cock; it has the disadvantage of added bulk, thereby making the guidance of the needle somewhat more difficult.

ADMINISTRATION OF MERCURY

This drug may be given by inunctions, by hypodermics, by mouth administration, by vaporization, by intravenous injections, named in the order of their safety and usual efficiency. Excepting the intravenous injections, the amount of mercury actually absorbed as the result of any of these methods varies greatly from time to time. Hence, while during a long-continued and uninterrupted course the administered dose of mercury remains the same, symptoms of uncontrolled disease may appear at one time, those of drug poisoning

at another. The intramuscular injection of insoluble salts seems almost as uncertain and irregular in its absorption as does the mouth administration. Inunctions and intramuscular injections of soluble salts are safer and less subject to wide variations. In whatever form it be given, the dosage of mercury is the largest which can be taken and absorbed without prejudice to the general health.

Salivation is never to be produced, and the drug should not be pushed to the development of even early symptoms of this condition. These are: (1) fetor of the breath; (2) a thickening of the saliva and an increase in its quantity; (3) boggy swelling of the gums around the teeth, and a tendency to bleed on slight irritation—so-called sponginess of the gums; (4) slight tenderness of the teeth when they are snapped together, and a feeling as though they were somewhat longer than they should be; (5) a metallic taste in the mouth.

It is only when the mouth and teeth are clean that these symptoms are valuable as an index that the system is taking all the mercury it can absorb without producing marked toxic effects. When the teeth are dirty, caked with tartar, decayed, and clogged with masses of decomposing organic matter, from carelessness in the use of tooth-brush and tooth-washes, or from neglect in seeking the aid of the dentist, salivation will occur from doses of mercury far below those necessary to saturate the system to the limit of safety.

If, during the course of the treatment, the mucous membrane of the mouth becomes sore or the gums boggy, cleansing or antiseptic mouth-washes, such as saturated solution of potassium chlorate, alternating with one of boric acid, listerine, and water, equal parts of each, or a weak solution of boric and tannic acids are indicated; such mouth-washes have a prophylactic influence against the development of salivation. Applications of a four per cent. solution of eucaine lactate relieve the pain incident to eating. Sweating, baths, laxatives, and diuretics are indicated as means favoring the elimination of mercury.

The weight during the course of treatment should be carefully noted. Stationary or increasing weight is a favorable sign. A decrease without obvious cause, when this decrease is rapid and progressive, means unchecked disease or toxic dosage.

Under mercury alone, there is steady, often rapid, subsidence of all symptoms. Lymphatic adenopathy diminishes, and often disappears completely, though there may remain traces of the original swelling; the eruption fades, and the agonizing pains and high temperature which sometimes usher in the secondaries subside promptly.

The end to be obtained is repeated full treatments over a long period, with intervals of rest. The dosage should be just short of the production of mercuric intoxication, or injuriously affecting metabolism; even a mild ptyalism is to be scrupulously avoided, since it increases tissue vulnerability. When mercury is being properly administered the patient, in addition to being free of symptoms characteristic of syphilis, should gain rather than lose in weight, and should have a special sense of well-being.

Mouth Administration

There are some patients to whom mercuric treatment cannot be given by other means, and many in whom this method is as efficient as any other, and less disturbing. The latter are represented by those who can take a dose sufficient to control symptoms without disturbing digestion or causing colic. The irregularities of absorption are perhaps greater than those incident to other methods, hence if mercury be routinely given by the mouth the method should be varied occasionally by dermal or subdermal methods.

As a routine practice, it is well to adhere to the administration of the protiodide, the bichloride, or gray powder, preference being given to the first drug, the others being employed only when the protiodide produces undue irritation without favorably influencing the course of the disease.

When few remedies are tried, the surgeon becomes more familiar with their strength and special properties, and hence is more likely to employ them skilfully than if he used many salts of mercury, the special reactions of which are unknown to him.

If the protiodide is selected, compressed tablets are ordered, each containing one-third to one-sixth of a grain.

The patient is directed to take three pills daily for the first three days, four for the second three, five for the third, and so increase the dose by one pill every third day, the salivary secretion, the urine, the gastro-intestinal condition, the body weight, and the mental attitude being carefully observed, usually at intervals of three days.

The patient's reaction to the drug is most certainly shown by metallic taste, fetor of the breath, and loss of weight and appetite. Mild colicky diarrhœa is frequently considered a sign that the full dose of mercury has been reached; this symptom, however, shows only the reaction of the intestinal mucous membrane to the particular preparation of mercury that is being used. Colic and diarrhœa may occur long before enough mercury has been given to influence the course of early syphilis. These symptoms indicate defective absorption of the drug, and show that only a fractional part of the daily dose administered is reaching the general circulation; hence the adoption of colicky diarrhœa as a gauge of constitutional susceptibility may lead to error, and may result in insufficient treatment and its disastrous consequences.

If during early treatment colic and diarrhœa develop before the manifestations of syphilis are markedly influenced for the better, the protiodide should be withdrawn, and in its place pills of mercury and chalk should be administered:

Tab. Hydrarg. cum creta., gr. i.
No. 50.

These pills are administered exactly as are those of protiodide of mercury, beginning with three pills a day and gradually increasing the dose till it is evident that the lesions are rapidly disappearing. A grain of mercury and chalk produces a somewhat less powerful effect than the third of a grain of protiodide.

If the gastro-intestinal irritation persists, unaccompanied by symptoms of ptyalism, bichloride of mercury may be tried.

℞ Hydrarg. chlorid. corrosiv., gr. iv;
Confect. ros., q.s.
M. et ft. pil. no. lx.

℞ Hydrarg. chlorid. corrosiv., gr. ii;
Mucilag. acaciæ,
Aquæ, āā ℥iv.
M. S. Teaspoonful freely diluted, as directed.

If the change to these prescriptions is not successful in subduing the symptoms of gastro-intestinal irritation, another method of introducing mercury is indicated.

When the patient is so situated that such change is impossible, opium in sufficient quantity to control the diarrhœa may be combined with one or other of the formulæ already given until the full dose is determined by rapid disappearance of symptoms. It should then be withdrawn, since it tends to constipate, to reduce appetite, and generally to influence the system unfavorably.

The best method of administering opium, when this is required to determine the full dose, is in the form of paregoric. With each mercurial pill the patient is directed to take the smallest number of drops which will prevent griping diarrhœa; thus the minimum efficient quantity can be found and can be administered in a form towards which the stomach is fairly tolerant.

Zittmann's decoction is an elaborate preparation, containing sarsaparilla, calomel, cinnabar, alum, anise- and fennel-seeds, senna leaves, and liquorice root. The special virtue of this decoction is incident to the elimination produced by diaphoresis and purgation. For details and technique of its administration, see p. 886.

Blue mass is a favorite with many syphilographers. The best combinations of this drug are as follows (Bumstead):

℞ Mass. hydrarg., ℈ii;
Ferri sulph. exsiccat., ℈i;
Ext. opii, gr. v.
M. et in pil. no. xx div.
S.—One pill from two to four times daily.

℞ Mass. hydrarg., ℈i;
Hydrarg. chlorid. mit., ℈ss;
Hydrarg. cum creata, ℈ii;
Ext. opii, gr. v.
M. et in pil. no. xx div.
S.—From two to four pills daily.

The last prescription is ordered when a rapid constitutional effect is desired.

The tolerance to mercury is greatly increased by hot baths taken daily during the course of treatment, preferably hot-air baths; when these cannot

be obtained, hot-water baths. Against hot baths some patients exhibit a prohibitive idiosyncrasy.

Inunctions

In prescribing mercury, the patient is ordered freshly made Unguent. Hydrarg. (50 per cent. Hydrarg.) put up in cachets or waxed paper. The average dose for men is ʒi for six days in succession, with an interval of five days, or double or triple this dose is at times needful, the quantity administered being increased till the specific lesion for the cure of which it is given shows signs of involution. For women the average beginning dose is forty grains. When the skin is hypersensitive an equal quantity of petrolatum may be added. Mercurettes about two-thirds as strong, made with cocoa butter as a base, are equally efficient and more convenient. Or mercurial ointment capsules may be ordered (mercury 33 per cent., lanolin 45 per cent., olive oil 6.6 per cent., white petrolatum 15 per cent.), each containing ʒss–ʒi.

The patient should provide himself with an undershirt of a thickness suitable to the time of year and of such quality or condition that no great loss will be suffered from its being permanently stained. This should be worn every night of treatment without being washed, the ordinary night clothes being put on over it.

Whenever practicable, he should do his own rubbing, beginning after his first hot bath (air, vapor, or water). He should, after his bath and immediately before retiring, occupy fully ten minutes in rubbing in the amount of ointment prescribed for one treatment.

Since this ointment irritates the skin if its application is too frequently repeated in one place, different surfaces are selected on successive nights. These surfaces should be comparatively hairless and fairly accessible. The regions of preference are the antero-internal surfaces of the arms and forearms, the sides of the thorax, the flanks, and the antero-lateral surfaces of the abdomen. When the nurse does the rubbing, the whole back may be included. By passing from one to the other of these regions in a definite order no one of them need be used oftener than once a week, thus giving plenty of time for the subsidence of any slight irritation which the inunction may occasion. After the inunction the patient puts on his undershirt and night clothes and goes to bed. The following morning he bathes and dresses as usual, removing the stained undershirt.

If there is marked skin irritation in any particular locality, this whole region is carefully washed with soap and hot water and dusted with a mixture of starch and bismuth, or stearate of zinc. Inunctions are taken before going to bed simply as a matter of convenience; they may be given at any time during the twenty-four hours.

The patient resumes at night after his next rubbing the undergarments already soiled by the ointment. The continued surface application of that portion of the ointment remaining after all has been rubbed in that the skin will receive seems to be an important feature in bringing about full absorption.

It is undoubtedly true that some persons exhibit an idiosyncrasy against inunctions, eczematous eruptions appearing over the entire body, and in the blonde and thin-skinned the local irritation is sometimes so great that this method of treatment is not applicable.

In place of ointments, mercurial soaps have been advised. These are, however, more uncertain in their effects and less accurate in their composition than ointments, and, although cleaner, require more time in their application. Schuster employs a soap commended by Charcot, which is made of equal parts of mercury, mutton suet, and potash soap. These ingredients are gently heated, and to them is added enough potassium hydrate to produce saponification. This mixture is rubbed into the skin for from fifteen to twenty minutes exactly as is mercurial ointment.

Mercury plasters have also been proposed, but have as yet received scanty recognition. Chassaignac employed the emplastrum de Vigo cum mercurio, which contains metallic mercury triturated with styrax and turpentine and added to ordinary lead plaster. Quinquaud obtained excellent results from a calomel plaster made by suspending 1000 parts of calomel in 300 parts of castor oil and adding 3000 parts of melted diachylon plaster. This mixture is spread on linen, is applied to the skin, and is kept on for eight days. The plaster should be about sixteen inches square, and should contain about three drachms of calomel.

Intramuscular Injections

The specific claims made for this treatment are as follows: (1) A precise dosage is obtainable; (2) it saves time and labor on the part of both physician and patient, visits being rendered infrequent; (3) it necessitates little change of diet or of habits of life; (4) the patient's skin and digestive organs remain unaffected, except in rare instances; stomatitis is exceptional; (5) the disease is readily concealed; (6) there is lessened expense; (7) permanent cure is accomplished in a short time and with a minimal amount of mercury; (8) a powerful influence is exerted readily and surely in the presence of grave and threatening visceral troubles; (9) the time required for a therapeutic diagnosis is shortened in doubtful cases.

On the other hand, evidence is adduced showing that the method does not assure accurate dosage (through irregular absorption), does not cure permanently or quickly, does at times, but not always, exert a prompter influence than can be obtained by other methods.

The disadvantages of the method are: (1) It is often extremely painful and is strongly objected to by many patients; (2) it is sometimes followed by dangerous and even rapidly fatal toxic symptoms; (3) it may have local sequelæ, such as erythema, cellulitis, abscess, and sloughing; (4) it is a treatment which cannot be carried out by the patient himself, but usually requires frequent visitation to the surgeon.

The drugs employed in the hypodermic method of treatment are either soluble or insoluble. In each class there are many preparations. Those most widely used are corrosive sublimate, the cyanide, the benzoate, the salicylate, and metallic mercury. Even with careful antiseptic precautions, abscesses occasionally develop.

The pain incident to these injections varies greatly; occasionally it lasts for hours or even days, and is usually more severe with the insoluble salts of mercury. Tenderness persists for some time, and may be so great as to occasion almost complete disability.

When a soluble preparation—and the best are corrosive sublimate, the benzoate, and the cyanide—is employed, the dose of the first two is from one-twelfth to one-third of a grain, of the last, one-seventh of a grain (0.01 Gm.). A hypodermic containing this quantity of the drug may be administered daily for from six to eighteen days; a period of rest half the length of the course is then given. When on account of its situation an outbreak of syphilis becomes immediately dangerous, as in the brain, and prompt action is imperative, larger doses may be injected.

These injections are indicated when syphilitic lesions are developing in spite of other methods of treatment or where there exists an idiosyncrasy against arsphenamine (salvarsan), or as an associated or supplemental treatment to arsenic, or when the intravenous arsphenamine or modern method of treatment is inadvisable on account of nephritis or other organic contra-indication, or when syphilomata are particularly obstinate. The favorite formula is the following:

℞ Hydrarg. chlor. corros., gr. 4⅘
Sodii chlor., gr. iiiss;
Aquæ destil., f℥i.

S.—One per cent. solution of corrosive mercuric chloride. Ten to thirty minims intramuscularly.

The benzoate in 2 per cent. solution with 2.5 per cent. sodium chloride is given in one-sixth to one-third-grain doses.

℞ Hydrarg. benzoat, gr. x;
Sodii chloridi, gr. xiiss;
Aquæ destil., f℥i.

The cyanide of mercury is conveniently employed in one per cent. solution put up in sterile ampules. The dose of this preparation is one cubic centimetre (0.01 Gm.).

Of the insoluble preparations administered hypodermically, metallic mercury and calomel are most efficient.

They are given in doses of ½ to 2 grains and ¼ to ¾ grain respectively at weekly intervals. Lambkin's formulæ for these preparations are:

℞ Hydrargyrum purum, 10 Gm.
"Creo-camph." * 20 c.c.
Palmitin basis, to 100 c.c.

Sig. 10 minims contains 1 gr. of metallic mercury.

℞ Calomel, 5 Gm.
"Creo-camph," * 20 c.c.
Palmitin basis, to 100 c.c.

Sig. 10 minims contains calomel ½ grain.

* Equal parts of absolute creosote and camphoric acid.

For the injection of mercury and its salts an all-glass syringe and platinum needle, 2 inches in length, about 20 gauge, should be used. When insoluble preparations are used, needle and syringe should be sterilized by heat in olive oil; the syringe is filled by removing the plunger and placing the mass in the barrel with the flat end of a probe.

The buttock, above and behind the trochanter, is the region of preference for the injection (Fig. 424); sometimes the muscles beside the spine in the thoracic region are used. The needle should be driven vertically into the tissues

FIG. 424.—Intramuscular injection of mercury. The cross (×) is over the trochanter, the line over the iliac crest.

down to the guard by one quick thrust. It should be observed for a moment to see if any blood flows from it, and, if not, the syringe should be attached and the injection driven in slowly. Successive injections are made on opposite sides.

The rate of absorption varies greatly, mercuric poisoning expressed in the form of stomatitis or gastro-enteritis may occur weeks after a series of injections; some accidents from emboli incident to an accidental venous injection are reported.

Thus administered, mercury usually exercises a prompt and powerful effect upon the lesions of syphilis, particularly those of the secondary stage of

the disease and certain affections of the eye and connective tissues. This effect is prolonged and continued, the drug presumably remaining at the point of injection as a magazine from which steady absorption goes on. Clinically the results are good and the accidents few.

In the tertiary stage, in conjunction with the iodides, this method of treatment is valuable when the integrity of vital organs is threatened and when the daily injection of soluble salts is not practicable.

Metallic mercury is usually preferred to calomel when no special urgency exists.

Value of the Intramuscular Method.—This, the fashion of the day, owes its vogue to its convenience. Moreover, it is clinically efficient, more so, as a rule, than mouth administration, less so than inunctions. But all three methods vary in individual cases, and from time to time in the same individual; hence none can claim accuracy of dosage.

Indications.—Mercury should be administered intramuscularly in those cases in which other methods of treatment have failed or cannot be applied because of especially sensitive conditions of either the gastro-intestinal mucous membrane or the skin, or because of an environment making it needful that the treatment be given by the doctor, and where prompt therapeutic effect is imperative.

Choice of Preparations.—The soluble salts are to be preferred to the insoluble in the large majority of cases, because of more rapid utilization and the lessened danger of local accumulation, with the sudden absorption of a toxic dose. The stability and solubility of the bichloride commend it as the salt of choice when soluble salts are employed.

Insoluble salts should be reserved for cases healthy except for syphilitics who cannot be depended upon to take intelligently inunctions or internal medication according to directions. Sailors, the passing type of drummers, and "rounders" still not "burnt out" well represent this type. Of the insoluble preparations, metallic mercury and calomel are to be preferred, the former for routine use, the latter when there are urgent symptoms, but daily injections of a soluble preparation are impossible.

Contra-indication.—In cases of crippled kidneys, diabetes, profound anæmia, marked atheroma, great debility, or any profound systemic dyscrasia, whether or not depending directly upon syphilis, the hypodermic method of treatment is dangerous.

Vaporization

This method of introducing mercury into the system has practically been abandoned as a routine practice, since it is more troublesome than other methods, is more difficult to apply privately, and is in the majority of cases not attended by better results. The drug commonly employed is calomel; the average dose is twenty grains.

The apparatus consists of an alcohol lamp placed beneath a metallic saucer, which is supported on a tripod. This apparatus is placed beneath a cane-bottomed chair, upon which the patient is seated naked and with a blanket pinned tightly around his neck and dropping to the floor, enclosing the body and the chair in a tent. Twenty grains of calomel are placed in the metallic dish, the

alcohol lamp is lighted, and the blanket is draped around the patient. The lamp is extinguished at the end of twenty minutes, and the patient is allowed to sit for twenty minutes longer in the calomel vapor; he then wraps himself in the same blanket that he has used during the vaporization, and retires to bed for a couple of hours, or for the night if the vaporizations are administered before going to bed.

There should be some one present, or at least within call, during these vaporizations, since the heat and the concentrated attention of the patient sometimes produce syncope.

This treatment is indicated when other methods have failed, and particularly in cases of widely diffused, small, hard, papular syphilides, or when obstinate or precocious ulcers are present.

Local vaporization is sometimes efficacious in the treatment of obstinate plantar or palmar syphilides. The foot or the hand may be kept in a box filled with the vapor of mercury for one or two hours daily.

Mercuric Baths, Thermal Springs, and Heat

Mercuric baths administered for the purpose of causing absorption of the drug have been little employed, since other methods are more exact and easier of application. The value of such baths, however, in combating by direct action certain widespread skin-lesions, and particularly in exerting an antiseptic effect upon pustular and ulcerating eruptions, thus minimizing or altogether preventing the effects of pyogenic infection, is undoubted.

In papular and pustular syphilides, papular and ulcerating gummata, and moist papules, the baths are serviceable, particularly in cachectic patients who do not well support vigorous treatment by the mouth. Tubercular and gummatous skin affections are also beneficially acted upon by this method of treatment.

When the whole body is not involved in the lesions the partial bath may be employed. Lesions about the genitalia and the rectum may be benefited by a sitz-bath, or in case of plantar or palmar psoriasis or syphilitic onychia the hands or the feet alone may be submerged.

The strength of the bath should be about 1 to 20,000, the temperature one comfortable to the patient, the duration at least two hours.

Thermal Springs.—In this country, the Hot Springs of Arkansas, abroad, the Baths of Aix, are widely known and extensively patronized for the supposed specific effects of the water upon syphilis. The general opinion of the profession is, however, that the waters of these springs have no special remedial value, and that hot salt baths at the sea-shore, or hot tub-baths at a wholesome mountain resort, would be equally useful to those who derive the most benefit from the springs.

The patients who should be sent to the springs are—

1. Those whose mode of life is unhygienic and who cannot be controlled while under home or other customary influence. This includes patients addicted to excesses, especially in the direction of alcohol and tobacco, and those whose devotion to work is so close and constant as to interfere with their general health.
2. Those whose symptoms resist full doses of the specific drugs or who are

unable to take large doses without a break-down of the digestive apparatus or the production of mercurial or iodic intoxication. Under such circumstances, should there be involvement of the viscera or of the brain or spinal cord, the Hot Springs treatment is particularly indicated. 3. Those who with syphilis have intense syphilophobia, and who require the mental impression and in addition the tonic influence of change of scene and climate. 4. Those with defective elimination or with marked idiosyncrasy as regards either mercury or the iodides.

The course of treatment adopted at the springs has for its active principle the administration of the specific drugs; practically no dependence is placed upon the waters as curative agents. Aided by the increased elimination and greater tissue-activity which these waters encourage, larger quantities of mercury and iodide are administered than would be tolerated under ordinary circumstances. The mercury is usually given in the form of inunctions, and, if the symptoms call for it, large doses of the iodides are administered.

Patients who come to the springs after a long mercurial course at home with the idea of "boiling out" the mercury, of which they suppose their system to be full, sometimes develop ptyalism after a number of baths, thus showing that the waters have an influence in increasing capillary circulation favoring tissue-change, and causing greater activity in the elimination of matter foreign to the tissues. Persons coming from malarial regions, though they have had no previous outbreak of malaria, after one or two weeks sometimes develop typical fever. Gouty subjects are liable to suffer from outbreaks of this trouble, and malignant tumors are prone to grow with increased activity. It seems reasonable to suppose that the increased tissue-change brought about by the hot baths will be useful in hastening the sequestration or destruction of the syphilitic infection. Moreover, the general health is often benefited by change of air and scenery.

Whatever be the action of the Hot Springs, it is true that under their influence patients in a profound state of cachexia who have been unsuccessfully treated by competent physicians sometimes improve rapidly, and that some cases of late syphilis are more quickly cured at the springs than at home.

Sulphur baths do not differ in reaction from those of ordinary springs. Sodium chloride and iodine brine baths seem, however, to increase oxidation.

The danger incident to bath treatment lies in over-confidence in the healing virtues of the springs, thus leading patients to stop all treatment after the symptoms have disappeared, with the idea that they are permanently cured, and substituting short and heroic treatment for the prolonged course which they require.

Hot Baths.—The value of hot baths as adjuvants in the specific treatment of syphilis is beyond dispute, and it is well to order as a routine practice during the time that mercury is administered the daily administration of a hot-air or hot-water bath, continued for ten to twenty minutes, and taken either at night on retiring or in the morning, according to the convenience or inclination of the patient.

The elimination of mercury is facilitated, larger quantities are tolerated, and in certain cases where without the baths doses of the specific far too

small to influence materially the lesions of syphilis produce beginning ptyalism, efficient doses can be given without untoward symptoms.

These baths, if of hot water, should be from 100° to 104° F.; if of air, from 150° to 180° F. In ordering them the question of idiosyncrasy should be fully considered; during their administration the patient should have an attendant at hand, in case syncope be produced.

Heat thus applied to the general surface increases the elimination of the mercury, even in the urine, probably because of the more active tissue-changes excited by the bath. Thus, when hydrargyrism develops, the application of the hot baths affords one of the most active and efficient means of relieving symptoms. The hot-air baths seem to be particularly serviceable, since they occasion free diaphoresis and elimination of the mercury through the sweat-glands; in consequence of the thirst they excite, bland liquids are ingested in large quantities, and these being taken up into the circulation tend to increase metabolism. A box heated with electric-light bulbs affords the best means of giving the hot-air bath. In the absence of electricity a flame in a box answers fairly well.

The local application of heat often markedly hastens the disappearance of syphilitic lesions when judicious treatment is employed at the same time. Heat may be applied locally in the form of baths, lasting for one or two hours, or, when these are not practicable, in the form of hot compresses wrung out of hot corrosive chloride solution and covered with a hot-water bag.

Indurations, gummata, periosteal nodes, and obstinate ulcerating syphilides are particularly amenable to the combined action of local heat and general specific treatment.

Intravenous Injection of Mercury

Intravenous injections of corrosive sublimate solution theoretically insure more exact dosage and a more rapid and powerful effect upon syphilitic lesions than when larger doses of mercury are given in other ways.

Nixon's method, modified by Thompson, is as follows: A 20-c.c. glass syringe half full of normal salt solution has added to it five to fifteen minims of a 2 per cent. solution of bichloride. After thoroughly mixing, the needle is introduced into a vein, the barrel of the syringe filled by drawing out 10 c.c. of blood, and, finally, this mixture of mercuric solution and blood is driven into the vein. This mixture does not cause thrombosis.

The method is useful in cases demanding intensive mercurial treatment in whom intramuscular injections of soluble preparations produce an unjustifiable amount of pain. The pain of intravenous injections skilfully administered with a fine, sharp needle is negligible.

The Elimination of Mercury

The elimination of mercury begins very shortly after the administration of the drug: thus, examination of the urine usually shows its presence two hours after intramuscular injection. The kidneys, the intestinal mucous membrane, and the salivary glands are chiefly active in eliminating mercury from the system.

THE TOXIC EFFECTS OF MERCURY

Hydrargyrism.—Hydrargyrism may be either acute or chronic. The symptoms of either of these conditions may be occasioned by the introduction of mercury into the system, whether it be by way of the alimentary tract, through the skin, as when the drug is administered by inunction, vaporization, or baths, or through the muscles and subcutaneous tissue, as when preparations of mercury are administered hypodermically. It should be borne in mind that lesions of the kidney particularly predispose to the development of hydrargyrism.

Acute Hydrargyrism.—The mild form of acute hydrargyrism is that already described. The symptoms are a slight ropiness or stringiness of the saliva, with increase in its quantity. During the night there is some flow from the corners of the mouth. The gums are slightly congested, and bleed readily when touched. This is especially noticed about the posterior molars when the teeth are healthy, but is frequently observed at the roots of the lower incisors, since here tartar is prone to collect, and hence the mucous membrane is more vulnerable. When the teeth are snapped together, slight tenderness will be noticed. Close upon these symptoms, often preceding them, come distinct metallic taste in the mouth and fetor of the breath.

If the drug is continued after these symptoms develop, and in some cases even though its ingestion be stopped at once, evidences of salivation become even more pronounced. The gums are greatly swollen and ulcerated. The teeth are loosened, the tongue—indeed, the whole mucous membrane of the mouth—becomes œdematous and congested, and erosions and ulcers appear upon its surface. There is an enormously increased flow of saliva, the submaxillary and parotid glands are swollen, cracks and ulcers appear at the corners of the mouth, and the breath is indescribably foul. In marked cases the patient is unable to masticate, to swallow, or even to speak, and the strength fails rapidly.

In some instances hydrargyrism expends its violence upon the alimentary canal and the kidneys, producing colicky, bloody stools, and albuminuria. This form of poisoning is, however, rare, save when the hypodermic method is employed.

Very exceptionally acute mercurialization appears in the form of skin eruption. This develops as an erythema, a dermatitis, or an eczema rubrum, and is always an expression of idiosyncrasy.

Chronic Hydrargyrism.—In certain cases the administration of mercury seems to produce a chronic catarrh of the gastro-intestinal mucous membrane. The patient suffers from the characteristic symptoms of this condition, the appetite fails, emaciation is progressive, albuminuria may appear, and there is complaint of great muscular weakness. A profound gloom seizes upon the patient, or he becomes nervous and hysterical. Since absolutely identical symptoms may be produced by the disease for the cure of which mercury is given, the determination of the cause of such symptoms is important.

When mercury has been administered in comparatively full doses for a long time, and when such symptoms develop and are progressive, it is wise to discontinue the specific drug, substituting a course of arsenical injections therefor, and to devote particular attention to diet, hygiene, and medication suited

to the cure of the gastro-intestinal catarrh. The improvement following such a course of treatment forms the best index to the etiology of the symptoms, though this improvement is always slow.

When such symptoms develop in cases which have been treated by insufficient doses of mercury it may be assumed that they are the effect of syphilis, and that on pushing the drug they will probably disappear. Albuminuria may be due to mercury or to the action of syphilis. The cause can be determined only by the therapeutic test.

Hydrargyrism is said to produce tremblings, attacks resembling epilepsy or apoplexy, cerebral palsies and anæsthesias, cephalalgias and arthralgias, disturbances of sleep, vertigo, and dementia. These symptoms are chronic in type, and yield slowly on cessation of treatment. Fortunately, they are uncommon.

Treatment.—Salivation is best avoided by minute attention to the hygiene of the mouth and by frequent inspection of the patient, so that the drug may be stopped or its dosage diminished on the development of the first symptoms. When patients cannot be kept under observation they should be told the symptoms of beginning ptyalism, and should be instructed properly to regulate the dose in the event of such symptoms developing. Daily hot, sweating baths constitute the most potent remedy.

Potassium chlorate is used as a mouth-wash in the form of a saturated aqueous solution. A teaspoonful of the salt is added to a glass of water, and the patient is instructed to rinse his mouth with this mixture every few minutes.

In alternation with this a disinfectant and astringent lotion may be employed, such as—

℞ Acid. boric.,
Acid. tannic., āā ℈iv;
Mel. rosæ, f℥ii;
Aquæ, q. s. ad f℥vi.
M. S.—Use as a mouth-wash.

Atropine should be given in small doses, frequently repeated, until some effect upon the pupil is noted. The drug may be administered in powder form, dropped on the tongue, and allowed to dissolve.

℞ Atropinæ sulphat., gr. $\frac{1}{50}$;
Sacch. lactis., q. s.
M. et ft. chart. no. x.
S.—One powder every three or four hours.

In severe forms of salivation, ulceration and eroded patches should be touched with five to ten per cent. solution of silver nitrate, and such solutions should be employed as hydrogen peroxide in spray form, phenol sodique, or potassium permanganate 1 to 1000.

The pain incident to taking food may be allayed by painting the gums and eroded patches with a four per cent. solution of eucaine just before eating.

The elimination of mercury from the system is materially hastened by prolonged hot-air or vapor baths, and by the administration of diaphoretics, diuretics, and laxatives; the hot-air baths are the most helpful single measure.

If the diagnosis of chronic hydrargyrism is assured, withdrawal of the drug and the inauguration of a tonic and stimulating course of treatment are indi-

cated. Change of air and surroundings is particularly serviceable, especially when reinforced by scrupulous attention to hygiene and ferruginous tonic. In case mercury is subsequently indicated, it should not be administered by the mouth.

THE SYSTEMATIC TREATMENT BY IODIDES

Potassium iodide is the preparation commonly employed. The administration of this drug is rarely indicated before the end of the second year, and is then given usually in combination with mercury. No germicidal effects can be claimed for the iodides.

The commonly accepted theory in regard to their action is that they powerfully stimulate the absorption of exudate. The lesions of late tertiary syphilis are particularly characterized by excessive cell-growth and accumulation of imperfectly organized tissue, made up for the most part of a small round-cell infiltrate, due to recrudescence of activity at the seat of former disease, to vascular and perivascular lesions, or to a crippling or obliteration of lymphatics incident to the long-continued hyperplasia of the secondary stage. The clinical proof is convincing that iodides are more potent than other drugs in promoting fatty degeneration and absorption of the imperfectly organized exudates.

The iodides may be satisfactorily administered in sarsaparilla as an excipient, not because this exerts any marked alterative effect, but rather because it disguises the taste of the drug. The following formula may be employed in the mixed treatment:

℞ Hydrarg. iodid. rub., gr. iv;
Potassii iodidi, ʒss;
Syr. sarsaparillæ comp., fʒvi.
M. S.—Teaspoonful in three ounces of water four times daily.

When patients object to taking this prescription, the iodide may be given in the form of saturated solution, one drop of which represents approximately one grain of the potassium iodide:

℞ Potassii iodidi, ʒi;
Aquæ, q. s. ad fʒi.
S.—Five to ten drops three times a day in half a glass of milk or water, increasing the number of drops as required.

Or the iodide may be given in the form of compressed tablets, mercury being administered at the same time, as previously directed. Occasionally other combinations of iodine are better tolerated than the potassium salt, and in certain cases a combination of the three best known salts will be found more serviceable than any one administered singly, thus:

℞ Potassii iodidi,
Sodii iodidi,
Ammonii iodidi, āā gr. xcvi;
Syr. aurantii cort., fʒi;
Aquæ, fʒv.
M. S.—Teaspoonful, freely diluted, four times daily.

When the iodide is given in the form of saturated solution the taste may be almost completely disguised by dropping the required dose in a glass of milk.

When it disagrees with the stomach,—and this is often the case,—it may be combined with essence of pepsin in the proportion of five to ten grains in a teaspoonful. Or it may be made into a junket, which with proper seasoning completely hides the taste of the iodide. Moreover, when administered in this manner, the stomach becomes tolerant to a remarkable degree. The most important practical point in securing the fullest good effects of the iodides with the least harmful results is to give them in dilute solution. The ordinary dose is given in six to eight ounces of water, and is soon followed by another tumblerful. Hot water still further facilitates the proper absorption of the drug. Iodides should be given about an hour after meals. If they occasion griping pains, tannic acid may be added to the prescription, or the following formula may be used:

℞ Potassii iodidi, ℥ss;
Syr. corticis aurantii, f℥vi.
M. S.—A teaspoonful in water three times daily.

The iodides should be given:

1. For the cure of gummata, extensive diffuse infiltrations, vascular lesions, and those of the central nervous system.

2. In precocious secondary syphilis,—that is, when the lesions resemble in type those of the tertiary period, affecting the fibrous or connective tissues, the bones, the nerve-centres, and important viscera, or when they appear in the form of deep ulcers or infiltrations of the skin.

The dose of the iodides is, as in the case of mercury, greatly influenced by individual peculiarity. Except when the symptoms are urgent and the integrity of an important organ, such as the brain, is threatened, the initial dose should be five grains three times a day. This should be increased by five grains every third day until the symptoms for which the drug is administered have disappeared, or until toxic symptoms denote that the therapeutic dosage has been passed. The production of the toxic symptoms is not indicative that the full physiological or therapeutic effects of the drug have been obtained. To increase the iodides until the symptoms are relieved sometimes leads to the administration of enormous doses, but the evil effects of these are usually far less to be dreaded than the results of insufficiently treated syphilitic lesions of important organs. Thus pushed, the iodides may cause the disappearance of osteocopic pains and motor and sensory palsies, and even at times the reëstablishment of mental faculties after they have been persistently and to all appearance hopelessly disordered. It should not be forgotten that conditions other than those caused by syphilis may be alleviated or cured by full doses of the iodides, thus obscuring the value of the therapeutic test.

The alleged value of tolerance of iodides as a sign of syphilitic dyscrasia is without foundation.

The value of the iodides is so slight in the ordinary cases of secondary syphilis that it is more than counterbalanced by their irritant effect upon the respiratory and gastro-intestinal mucous membranes. As a rule, their therapeutic value increases in direct ratio with the age of the syphilis, but even in early

syphilis the iodide should be added to the mercurial treatment whenever extensive and dense exudation has occurred, whether in the deeper layers of the derm, in the subcutaneous connective tissue, in the periosteum or bone, or in the viscera. There is nothing more satisfactory in therapeutics than the direct and unmistakable benefits following the administration of the iodides in such cases.

Several formulæ have already been given for the administration of iodides. A saturated solution (potassium iodide, ℥i; water, q. s. ad ℥i) is the most convenient form in which to administer the drug when it is given in ascending doses. In addition to this preparation the patient may be ordered compound syrup of sarsaparilla, to a tablespoonful of which the required dose of iodide can be added, the patient immediately afterwards taking one or two glasses of water or milk. Free dilution is essential in avoiding gastric irritation.

Iron iodide is a valuable preparation, particularly when syphilitic anæmia is marked. This may be given either in pill form or as a syrup.

The Toxic Effects of the Iodides

Under the general heading iodism are included the various toxic symptoms which may develop in consequence of over-dosage with this drug. Those commonly observed are gastro-intestinal irritation, coryza, pustular skin eruption, lachrymation, tinnitus aurium, and mental depression. Exceptionally neuritis and acute œdema of the larynx are occasioned by comparatively mild doses of the iodides.

As in the case of mercury, iodides are most prone to produce untoward effects in those suffering from kidney degeneration.

The lesions of the iodide dermatoses may simulate almost any of the recognized forms of acute cutaneous eruption. They commonly appear in the form of acne, but erythema, eczema, and herpes are by no means rare. Purpura is frequently observed, and even sloughing, gangrenous ulcers are occasionally noted.

These eruptions are due to idiosyncrasy and bear no definite relation to the dose employed. In some instances small doses produce toxic effects; in others heroic doses are taken with impunity.

In the dose ordinarily employed in the treatment of syphilis a large proportion of patients will exhibit no symptoms whatever from the use of the iodides. A larger proportion will be troubled with a coppery taste in the mouth and with an acneiform eruption, affecting the face by preference, but often widely distributed. Coryza, lachrymation, slight conjunctivitis, and symptoms of indigestion incident to gastro-intestinal catarrh are also common. A very small percentage of the cases will suffer from swelling of the mucous membrane of the larynx and pharynx, sometimes so great as to endanger life, and from an especially severe skin eruption much like furunculosis, which may go on to the purpuric or the sloughing form.

Treatment.—The treatment of iodism depends upon the severity of the symptoms. In the milder cases, and particularly when it is important to continue administering the drug for the purpose of effecting resolution and absorption of syphilitic deposits, the iodide may be continued, or the dose may be slightly increased, since in most cases tolerance is established and the

coryza and eruption disappear. A few drops of Fowler's solution may be administered together with the iodides. The gastro-intestinal symptoms are controlled by carefully regulating the diet, administering slightly astringent and antiseptic digestive powders, and giving the iodides largely diluted, preferably in milk to which essence of pepsin has been added. Or, if this method is not feasible, each dose of the drug should be dissolved in a full glass of soda-water, flaxseed tea, or other bland excipient.

Vegetable Infusions and Decoctions

These are sometimes useful as adjuvants in the treatment of syphilis, but have no specific action of their own. The two best recognized are the following:

Succus alterans (McDade's Formula).

℞ Ext. smilacis sarsaparillæ fl.,
Ext. stillingiæ sylvat. fl.,
Ext. kappæ minoris fl.,
Ext. phytolaccæ decand. fl., āā f℥ii;
Tinct. xanthoxyli carolin., f℥i.

M. S.—Take a teaspoonful in water three times a day before meals, and gradually increase to tablespoon doses.

This may be employed in alternation with the mixed treatment where daily dosing of the latter cannot be borne.

When the appetite, digestion, or nutrition needs attention, the following tonic is useful:

℞ Strychninæ sulphat., gr. i;
Acid. phosphoric. dil., f℥iii;
Liq. pepsinæ, q. s. ad f℥vi.

M. S.—One teaspoonful in water after each meal and before going to bed.

Zittmann's treatment of intractable syphilis has for its underlying principle elimination by diaphoresis and purgation.

The evening before the treatment is begun, the patient receives two pills, each containing two grains of calomel, five grains of compound extract of colocynth, and two grains of extract of hyoscyamus. The remainder of the treatment consists in the use of two decoctions. The first contains sarsaparilla root four ounces, anise- and fennel-seed each five hundred grains, senna leaves one ounce, and liquorice root four ounces; these are bruised and added to four gallons of water, together with eighty grains each of white sugar, alum, and calomel, and twenty grains of the red sulphide of mercury enclosed in a linen bag; the water is then boiled down gently to one gallon. This is decanted and constitutes Decoction No. 1. Its dregs are put into three gallons of water, with two ounces of sarsaparilla root, and one ounce each of lemon-peel, cardamom seed, and liquorice root, and boiled down to one gallon. This constitutes Decoction No. 2.

The morning after taking the purgative pills, and each day after this, the patient drinks half a pint of hot decoction No. 1 at nine, ten, eleven, and twelve o'clock, and in the evening half a pint of cold decoction No. 2 at three, four, five, and six o'clock. He is kept in bed except for one hour each evening. On the fifth day he takes a hot bath and is allowed to dress. On the evening of the fifth day two of the above pills are again administered, and the next day the routine treatment is resumed. The whole course lasts fifteen days.

LOCAL TREATMENT OF SYPHILIS

The Chancre.—Intravenous treatment with salvarsan or neosalvarsan promptly cures the chancre. The surface of the ulceration should be kept clean by means of antiseptic sprays or washes, to avoid mixed infection, and thereafter dusted with zinc stearate and calomel, equal parts by weight of each; or, if the inflammation be acute, the sore should be wet dressed every two hours, two per cent. boric solution or four per cent. sodium chloride answering well.

When there is a tendency to form crusts, salves are useful:

℞ Emplast. hydrarg.,
Cerat. resin., āā ℥ss.
M. S.—Use locally.

℞ Zinci oxidi, gr. v;
Ac. borici, gr. xl;
Petrolati, q. s. ℥i.
M. S.—Use locally.

If the granulations are sluggish, touching with a five per cent. silver nitrate solution is desirable.

When the chancre is covered by a tough pseudo-membrane, beneath which ulceration is extending, probably from the reaction of the ordinary pus-microbes, destructive cauterization may be necessary. Nitric acid or acid mercuric nitrate may be employed, the surrounding tissues being protected by oiled cotton; antiseptic fomentations should follow.

Gangrenous and phagedænic chancres require the same local applications, or the actual cautery, supplemented by tonic and supportive treatment.

Of the dry powders, zinc stearate is the most serviceable. It may be administered pure or mixed with powdered boric acid, calomel, or starch. Calomel may also be mixed with an equal quantity of lycopodium. Dermatol is an astringent, healing antiseptic, free from irritating properties and devoid of unpleasant odor. It may be used either as a powder or as an ointment. Aristol is also serviceable. The dry powder is inert, hence it should be dusted on the surface of the lesion and a drop of olive oil allowed to fall on it from a glass rod; it should then be covered immediately with some thin, impermeable substance, under which solution takes place slowly. No cotton or charpie should be applied to the ulcer. The dressing should be renewed twice daily.

To chancres not covered by crusts or pseudo-membrane and exhibiting but slight inflammatory reaction, flexible collodion may be applied.

To urethral and rectal chancres iodoform in the shape of suppositories may be applied after copious flushing with dilute corrosive chloride solution (1 to 10,000). These suppositories, made of cacao butter or gelatin and of appropriate shape and size, should contain from two to five grains of iodoform. Gray ointment diluted with three parts of vaseline is also serviceable in the local treatment of these lesions.

Chancres of the tongue, mouth, or tonsils are treated by frequent gargling with cleansing and nonirritating mouth-washes, and local applications of silver nitrate solution (1 to 10).

The Syphilides.—Skin lesions may be benefited by applications of mercury to the surface and the systematic employment of hot baths.

Erythematous syphilides usually require no local applications. When they are sufficiently persistent and conspicuous to demand treatment, the following formulæ will be found useful:

℞ Hydrarg. chlorid. mit., ʒi;
Unguent. zinci oxidi,
Unguent. petrolei carbolat., āā ℥ss.

M. et ft. ung. S.—Apply locally.

℞ Hydrarg. chlorid. mit.,
Pulv. amyli, āā ʒi.

M. S.—Dust lightly over the parts affected.

Papular syphilides are often obstinate, and are especially benefited by (1) vapor baths; (2) inunction and massage; (3) ointments containing mercury in one of the following formulæ:

℞ Ung. hydrarg. nitrat.,
Ung. petrolei carbolat., āā ℥ss.

℞ Hydrarg. ammoniat., ℈i;
Unguent. aquæ ros., ℥i.

These ointments are especially serviceable in the papulo-squamous eruptions. When these attack the hand, a region in which they are persistently recurrent, the local vapor bath proposed by Wells is particularly efficacious. The interior of an inverted hat-box is filled with calomel vapor by means of a small alcohol lamp placed beneath a metal dish containing calomel, and the hand is introduced within the box through a hole cut in the side.

Mucous Patches.—These, for the most part, may be prevented from appearing in the mouth by taking the precautions already mentioned (p. 870). When they appear, they should be painted two or three times daily with a one to ten per cent. solution of silver nitrate, or touched with the solid stick, and an antiseptic mouth-wash should be used, such as the following:

℞ Acid. boric.,
Acid. tannic., āā ℈ii;
Mel. ros., f℥ii;
Aquæ, f℥vi.

M. S.—Use as a mouth-wash.

Or sprays of listerine, Dobell's solution, or hydrogen peroxide may be employed. Iodine, applied to the lesions, is stimulating and resolvent:

℞ Iodi,
Potassii iodidi, āā ʒii;
Glycerini, q. s. ad f℥i.

M. S.—Apply locally.

The scaly patches should be touched every second or third day with ten per cent. chromic acid solution or acid mercuric nitrate half strength. If they still persist, they should be removed by the sharp curette or the actual cautery.

Ulcerated patches in the throat are benefited by the same treatment; cleans-

ing sprays are particularly serviceable. In addition, fumigations may be administered, as advised by Mauriac:

℞ Hydrarg. iodidi vir., ʒss;
Carb. lig., ʒiss;
Benzoin., gr. viiss;
Aquæ, q. s.
M. et ft. trochisci no. xx.
S.—One to be burned morning and night, and the vapor inhaled.

The use of tobacco must be given up entirely, and the mouth kept scrupulously clean.

Condylomata, if vegetating and exuberant, should be cauterized with nitric acid, acid mercuric nitrate, or chromic acid. These last two drugs may produce toxic symptoms. Indeed, death has resulted from the topical application of the latter: hence it should not be applied to a large surface.

℞ Acid. chromic., ʒii;
Aquæ, fʒiii.
M. S.—Apply locally, to a limited area.

The vegetations may also be destroyed by the use of the following mixture:

℞ Plumbi oxidi, gr. iv;
Liq. potass. caust. (33 per cent.), ♏cxvi.
M. S.—Caustic. For external use only.

A single application is usually efficient; sometimes two or three applications are required at intervals of two or three days. After this caustic is applied, the affected surface is dusted with stearate of zinc. A cicatrix forms in from three to ten days.

Small lesions disappear after painting with:

℞ Acidi salicylici, gr. xxx;
Collodion (flexilis), ʒi. M.

Mild cases require no local treatment beyond cleanliness, drying, and dusting with calomel.

When the papillary overgrowth is extensive, it should be removed by the cautery knife, the resulting raw surface being closed by skin transplantation if necessary.

Pustular and Pustulo-Crustaceous Syphilides.—It is particularly in this class of cases that the mercury and vapor baths are serviceable, supplemented by the calomel and zinc ointment (see p. 888). The latter may be used on the face at bedtime. When the ulcerations are indurated and crusted the following prescriptions may be used:

℞ Hydrarg. bichlorid., gr. ii;
Unguent. hydrarg. nitratis,
Ung. petrolei carbolat., āā ʒss.

℞ Hydrargyri oxidi rub., ʒii;
Unguent. zinci oxidi, ʒvi.

Leg ulcers should be cleansed, strapped, and bandaged. If they refuse to heal under this treatment, the whole surface and the surrounding skin may be covered in with a piece of thinly spread plaster containing equal parts of emplastrum hydrargyri and emplastrum cerati; over this is applied a tight bandage which includes the foot and leg. Dressings should be repeated in accordance with the amount of discharge.

Tubercular Syphilides, Gummata, and Periosteal Nodes, when non-ulcerated, may best be treated locally by the continuous application over their surface of the following ointment spread on a piece of lint:

℞ Ung. iodi comp., ʒi;
Ung. belladonnæ, ʒii;
Ung. hydrarg., ʒiii;
Ung. petrolei carbolat., ʒiv.

This ointment may be combined with the local use of heat, a hot-water bag being applied to the lesion for as many hours a day as is practicable.

Chronic persistently spread serpiginous ulceration should be treated by the prolonged bath—days or weeks if necessary. If this fails, the actual cautery is indicated.

Ulcerations are curetted, cleansed, and treated on general principles. Carious and necrosed bones should be subjected to appropriate surgical measures.

In a few reported cases obstinate ulcerating syphilitic lesions which resisted specific treatment recovered promptly after an attack of erysipelas. There has been no formal effort, however, to utilize this fact in the treatment of such lesions.

THE TREATMENT OF HEREDITARY SYPHILIS

The treatment of inherited syphilis may be considered under the following heads:

1. The prophylactic treatment of the parents before conception;
2. The treatment of the mother during pregnancy;
3. The treatment directed to the child.

1. The PROPHYLACTIC TREATMENT before conception is that already described as appropriate to syphilis, except that more attention is paid to the general hygiene applicable to the sexual relations, and every effort is made to suppress by full doses of arsenic and mercury any manifestation of active syphilis and to maintain a persistent negative Wassermann.

Probably the most important point in prophylaxis, so far as the practitioner is concerned, is his advice in regard to marriage, or, if this has already been consummated, in regard to preventing conception from taking place.

Consent to marry may be given to patients who have been actively treated and whose Wassermann has been consistently negative for two years. When syphilis has been contracted after marriage the same conditions should obtain regarding the bearing of children.

When, in spite of due warning, or perhaps from lack of it, marriage has taken place and the sexual relations are established, active treatment of the mother is imperative.

2. The Treatment of the Mother.—Whether the mother is previously syphilitic, or has conceived by a syphilitic husband, or has contracted the disease after impregnation, she is treated in accordance with the principles already laid down. Mercury and arsenic are pushed and are advantageously combined with moderate doses of potassium iodide. Special care must be taken not to allow the medication to produce gastro-intestinal irritation, since this strongly predisposes to the production of abortion. When the mother is thus treated she will probably bear a living child, and one either healthy or exhibiting syphilis in a mild form.

3. The Treatment of the Child after Birth.—Since the pathology, stages, and general course of hereditary syphilis are similar to those of the acquired disease, treatment is conducted on the plan already described.

In hereditary syphilis the treatment is modified somewhat by the following considerations:

1. There is always a more or less profound cachexia influencing all the nutritive and formative processes, and in itself, aside from specific lesions of vital organs, threatening life.

2. During the secondary period lesions corresponding to the tertiary type, particularly gummata, are frequent.

The cachexia and its results are combated by supplementing the specific treatment by one which is stimulating and supporting. Special attention should be paid to the nutrition. The nurse of the child should, of course, be its mother, since it cannot convey the disease to her. If the child cannot be fed at the breast, its chances for survival are greatly reduced. The selection of the most nutritious and easily digested artificial food then becomes a matter of cardinal importance. Tonic treatment should be employed, iron iodide, cod-liver oil, and preparations of the hypophosphites being most useful.

Routine Treatment of Hereditary Syphilis

The children of syphilitic parents may exhibit characteristic lesions at birth; they may remain apparently healthy for several weeks and then suffer from typical secondaries; or they may remain free from signs or symptoms of syphilis through life.

When a child shows characteristic manifestations of the disease at birth, immediate treatment is indicated.

When an apparently healthy child is born of syphilitic parents and exhibits a negative Wassermann the indications are not so clear, since there is no certainty that the disease will ever develop. As a rule, it is safe to wait for characteristic symptoms or a positive Wassermann. An apparently healthy child with a positive Wassermann should be treated in accordance with the principles applicable to a syphilitic adult, the neosalvarsan and mercury being given in small doses (¼ to 1 grain of mercury with chalk, or 7½ grains of mercurial ointment; 0.001 to 0.004 gramme neosalvarsan for each pound of body weight). Neosalvarsan has been injected into the external jugular veins and veins of the scalp, made prominent by the child's crying, and into the superior longitudinal sinus, through the anterior fontanelle. When parental syphilis is recent, and has not received appropriate treatment, the child should

be given the specifics without waiting for symptoms or the serological reaction.

The routine method of treatment is as follows: four neosalvarsan intravenous injections, the drug being dissolved in a minimal amount of sterile distilled water, at intervals of two weeks. The fourth day following injection the surface of the child's abdomen is bathed with Castile soap and water, then with a saturated solution of boric acid, after which it is thoroughly dried. Mercurial ointment diluted with three parts of vaseline is then spread on the child's binder, and the latter is applied as usual in infants. Half a drachm of this dilute ointment may be used daily. After the binder has been worn for twenty-four hours the abdomen is again washed with soap and water, followed by boric acid solution; a half-drachm of the ointment is then rubbed into the skin, and the binder previously employed is again applied. This binder is changed for a fresh one every fourth day. The dose is regulated by its effect on the symptoms, if any be present, otherwise to keep well within the limit of affected nutrition. After the last dose of neosalvarsan, in the absence of clinical manifestations and with a negative Wassermann, no further treatment is needed. A persistently positive Wassermann calls for repetitions every six months for two years; thereafter a mercurial treatment spring and fall for life.

Should the prolonged application of the ointment produce dermatitis, the inflamed skin may be bathed with witchhazel and dusted with zinc stearate, carbolized talc, or other healing powder, the mercury then being administered in the form of inunctions, which are rubbed into the back, sides, and front of the chest, and the arms, thighs, and legs, a fresh skin surface being chosen each day.

Exceptionally, mercurial ointment, even though used in this way, occasions so much local reaction that its surface application must be abandoned.

When treatment by the mouth must be resorted to, probably the most efficient formula is the following:

℞ Hydrarg. cum. creta, gr. i–xii;
Sacch. alb., gr. xii.
M. et. div. in chart. no. xii.
S.—One powder three times a day; to be taken soon after nursing.

Externally, at the same time, a mild mercurial ointment may be used, or, better, the following may be kept in contact with the skin under pressure:

℞ Ung. hydrarg.,
Ung. zinci oxidi, āā ℥ss;
Bals. Peru., ℥i. M.

In conjunction with inunctions or the internal use of the powders of mercury with chalk, potassium iodide may be given in a syrupy solution, in doses varying from half a grain to a grain, or, if there be any marked tertiary symptoms, even in much larger doses, three or four times daily.

Occasionally nothing whatever will be retained by the stomach. Under such circumstances intramuscular injections are indicated. These injections are open to the same objections as obtain against this method in the adult. They are, however, often to be preferred to internal treatment, and should be administered in the manner already described.

The solution of choice is the one per cent. sublimate mixture (see p. 1880). Beginning with a dose of one minim (one-hundredth of a grain) every second day, the quantity injected is gradually increased to two, three, or four minims.

In addition to the medicinal treatment, special attention should be paid to cleanliness and hygiene. If possible, the life should be out of doors, and the food should be healthy and invigorating.

The indirect treatment of the child—*i.e.*, the administration of specific medicine to the nursing mother—is of possible utility when other methods have failed or must be temporarily interrupted.

TREATMENT OF SYPHILIS OF THE CENTRAL NERVOUS SYSTEM

Based on the fact that neither mercury nor arsenic, except in infinitesimal quantities, can be recovered from the cerebrospinal fluid, after being given in the usual way, and that hence neither drug can exert its inhibiting or destructive influence on the spirochætes lodged and multiplying in the central nervous system or its envelopes, there has been developed a method of subdural medication, particularly in regard to arsenic, which, seen through the eyes of individual enthusiasts, has been singularly efficacious in the treatment of the late tertiaries, particularly when manifested in the form of paresis or locomotor ataxia, or both. To unprejudiced observers there is as yet no convincing proof that such injections are helpful. These chronic maladies are subject to astonishing exacerbations and remissions without assignable cause, are nearly always helped by general hygienic supervision, and particularly by attention to elimination. The intraspinal treatment has usually been supplemented by intravenous injections; the improvement noted has not been greater than that observed after other methods, including those supposed to be specific and those which are certainly not so. In the light of present knowledge, resort should not be had to intraspinal medication so long as improvement clinically or in the character of the blood and spinal fluid is manifested from intravenous therapy. If the patient's condition becomes stationary, and is unsatisfactory, and the spinal fluid still exhibits abnormalities, as shown by the laboratory tests, despite intensive intravenous arsenic therapy in conjunction with the efficient use of mercury and the iodides, intraspinal medication by autosalvarsanized or salvarsanized autosalvarsanized serum may be considered in selected cases of early tabes dorsalis.

Swift and Ellis give a full dose of salvarsan or neosalvarsan intravenously, drawing off 40 c.c. of blood one hour later. This is clotted, centrifuged, and the clear fluid pipetted off. Twelve cubic centimetres of this serum are diluted with 18 cubic centimetres of normal salt solution, heated in a water-bath at 56° C. for one-half hour, and introduced subdurally by lumbar puncture. Swift does not find it necessary at present to dilute the serum as at first recommended.

Wile injects a watery solution of neosalvarsan; the contents of a 0.3-gramme ampoule is dissolved in 5 cubic centimetres of recently distilled water and from one to three drops (3 to 9 mg.) of this are given at a dose. The quantity of

solution to be used is first drawn into a syringe, the latter being then attached to the lumbar puncture needle through which cerebrospinal fluid is flowing. The syringe (10 cubic centimetres) is first sucked full of this fluid, thus diluting the arsenical solution, and the whole is then gently injected subdurally. After the injection the hips of the patient are raised higher than his head and so held for one hour. Ogilvie recommends for intraspinal injection the addition of salvarsan or neosalvarsan directly to the patient's serum, and this method is preferred by Fordyce as follows: To 8 or 10 c.c. of the patient's serum, free of red blood-cells, is added 0.05 to 0.5 mg. of salvarsan and the solution is incubated at 37° C. for half an hour, prior to intraspinal injection. Swift recommends that the serum of the salvarsanized patient be used for this patient.

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